Department of
Energy and Economic
Diversification

GOVERNMENT OF
WESTERN AUSTRALIA

Energy
Policy WA

Power System Security and Reliability (PSSR) Standards Review

Consultation Paper – Proposal 20

Adopting Western Power September 2023 Proposed Technical Rules Amendments

30 September 2025

Working together for a brighter energy future.

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1. Introduction

The Coordinator of Energy, in consultation with the Market Advisory Committee, is conducting a review of the Power System Security and Reliability (**PSSR**) Standards in the South West Interconnected System (**PSSR Standards Review**).

The purpose of the PSSR Standards Review is to implement the Energy Transformation Taskforce's recommendation to develop a consistent, single end-to-end PSSR Standard for the SWIS under a centralised governance framework. This revised framework will be implemented in the Electricity System and Market Rules (**ESM Rules**)[1].

The PSSR Standards Review is being carried out in four stages:

- Stage one involved a comprehensive review of the various PSSR related provisions across Western Power's Technical Rules, the Network Quality and Reliability of Supply Code 2005, the Electricity Networks Access Code 2004 and the ESM Rules. This included relevant standards, their governance arrangements, and the applicable monitoring, compliance and enforcement framework.
- Stage two involved considering any gaps, duplications, overlaps and inconsistencies in the existing standards and their governance arrangements.
- Stage three involved developing proposals for an end-to-end PSSR Standard governed by the Coordinator under the ESM Rules.
- Stage four will deliver the detailed design and Amending Rules, including any necessary transitional arrangements.

On 19 June 2025, Energy Policy WA (**EPWA**) published a Consultation Paper ('Stage 3 Consultation Paper') that represents the findings and policy proposals from the PSSR Standards Review.

The Stage 3 Consultation Paper included a proposal (proposal 20) for the ESM Rules to adopt certain PSSR related provisions from Western Power's September 2023 Proposed Technical Rules Amendments (2023 Proposed Technical Rules). Stakeholders were invited to review and provide comments on the relevant sections of the 2023 Proposed Technical Rules.

The window for submitting feedback on the Consultation Paper closed 7 August 2025 following a seven-week consultation period**.** Following stakeholder requests, EPWA is providing a further opportunity and time for stakeholders to review proposal 20, and the relevant sections of the 2023 Proposed Technical Rules, in this Consultation Paper.

Stakeholders are invited to provide feedback before **5:00pm (AWST) Tuesday, 11 November 2025** by submitting comments to energymarkets@deed.wa.gov.au. Late submissions may not be considered.

Any submissions received will be made publicly available on PSSR Standards Review web page unless requested otherwise.

[1] The *Electricity Industry Regulations Amendment (Distributed Energy Resources) Regulations 2025* commenced in February 2025. These regulations rename the Wholesale Electricity Market (WEM) Rules to the ESM Rules.

2. Stage 3 Consultation Paper: Proposal 20

2.1 Issues

Western Power identified issues with the current security and reliability framework in its July 2021 and September 2023 Technical Rules amendments submission to the Economic Regulation Authority.

Both submissions were subsequently withdrawn, as the proposed changes were closely linked to matters being addressed through the State Government's Energy Transformation Strategy reforms, including the PSSR Standards Review.

Subject to consultation, EPWA proposes to transfer aspects of the 2023 Proposed Technical Rules into the ESM Rules (proposal 20 in the Stage 3 Consultation Paper).

2.2 Proposal 20

The relevant sections of the 2023 Proposed Technical Rules that EPWA has suggested are transferred into the ESM Rules are listed in **Table 1.**

Stakeholders are encouraged to review the relevant 2023 Proposed Technical Rules (**Appendix A**) and Western Power's supporting document in (**Appendix B)**.

Table 1

Issue	Ref (in the supporting document)	Additional notes for consultation
Transmission voltage limits	3.4	Stakeholders are requested to focus on any implications arising from the Western Power's proposed technical limits and the inclusion of 'economic efficiencies' in clause 2.2.2.7(c).
Distribution voltage limits	3.5	**Distribution voltage limits can be clearer and aligned with wider limits adopted in other jurisdictions and AS 61000.3.100.** Since the time of the submission in September 2023 there have been changes to the Australian Standards. The revised proposal is to adopt the limits in AS IEC 60038: 2022 voltage standard, which stipulates a voltage supply range of +/- 10% under normal operating conditions
Standard for transient stability	3.6	
Standard for oscillations	3.7	Note that as per proposal 8, the term adequately damped is proposed to be replaced with adequately controlled in Appendix 12 of the ESM Rules. Feedback is being sought on whether the same amendment should be made to the provisions

Issue	Ref (in the supporting document)	Additional notes for consultation
		discussed in 3.7 of the Technical Rules submission.
Voltage stability	3.8	
Network Service Provider obligations - Stability and modelling*	3.9	
Network Service Provider obligations - Power system performance	3.11	
Network Service Provider obligations - System restart*	3.12	
UFLS requirements	3.13	Western Power's obligation to analyse and understand if the UFLS system meets required outcomes in support of AEMO's development of the UFLS requirements will be considered. Work will continue between EPWA, AEMO and Western Power to arrive at the right level of regulatory specification, noting that the framework will need to be harmonised under the ESM Rules.
Definition of credible contingency	4.2	**Definition of credible contingency to be clearer and take into account the change in certainty over planning and operational horizons.** The proposal presented in the Technical Rules amendments submission is predicated on the ongoing separation between the ESM Rules and the Technical Rules. As both frameworks will be integrated into the ESM Rules, attention will be given to ensuring the harmonisation of the credible contingency definitions.
Definition of plant ratings to adopt cyclic or short-term ratings	4.3	Stakeholder are requested to focus on potential impacts on the market of the proposed changes.
Duration of protection equipment being taken out of service	5.3	Western Power has proposed additional flexibility, for example through guidelines. Consideration will need to be given to whether a Guideline is the most appropriate

Issue	Ref (in the supporting document)	Additional notes for consultation
		instrument under the ESM Rules for these matters, and the means by which transparency, consultation and accountability is addressed.
Definition of equipment for which Critical Fault Clearing Times (**CFCTs**) apply	5.4	Consideration will need to be given to whether a Guideline is the most appropriate instrument under the ESM Rules for these matters and the means by which transparency, consultation and accountability is addressed.
Weak infeed assessments under islanding conditions	5.5	
Distinction between transmission and distribution protection operation for critical fault clearance times	5.6	
Review of user control and protection settings. System design and construction standards	6.2.6, 6.2.7	
Aligning protection and disturbance ride-through requirements	6.8.6	
Alignment with revisions to network planning criteria and Network Service Provider obligations	8.3	
Clarifying arrangements for planning network outages	8.5	
Clarifying acceptable timeframes for protection outages	8.9	
Wording of voltage control can be improved	8.10	

Consultation question

Do stakeholders support the proposal to accept the subset of the Western Power proposed amendments to the relevant Technical Rules requirements?

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APPENDIX 1

Technical Rules

DRAFT ONLY

Insert Date (proposed September 2023)

IMPORTANT NOTE: This document is subject to amendment (amendments must be made in accordance with the *Electricity Networks Access Code 2004*). The latest approved version of the Technical Rules (and details of any proposed amendments) are available from the Economic Regulation Authority: https://www.erawa.com.au/electricity/electricity-access/western-power-network/technical-rules

westernpower

PREFACE

The Electricity Networks Corporation, trading as Western Power, was established on 1 April 2006 by the *Electricity Corporations Act 2005* (WA). Western Power is required to provide access to capacity in its electricity *transmission and distribution systems* in accordance with the *Electricity Networks Access Code 2004* (WA) (*Access Code*).

Chapter 12 of the *Access Code* fully describes the context, approval, development and application of Technical Rules for covered and non-covered networks. As such, the Economic Regulation Authority (*Authority*) is required to approve and publish Technical Rules (*Rules*) for covered and non-covered networks in coordination with *Network Service Providers*.

These *Rules* detail the technical requirements to be met by:

1) Western Power, and

2) *Users* who connect *facilities* to the *transmission and distribution systems* that make up the *Western Power Network*.

Prospective *Users* or existing *Users* who wish to connect *facilities* (or modify existing connections) to the *transmission and distribution systems* must first submit an *access application* to Western Power in accordance with the *Access Code*.

Amendments to this document, and variations or exemptions to *Rule* requirements granted to *Users* and the *Network Service Provider*, can only be made in accordance with the *Access Code*.

[INSERT DATE], Revision x (DRAFT)

This *revision* of the Technical Rules contains amendments approved by the *Authority* decision of [insert date]. That decision relates to amendments proposed by Western Power in [insert date], and the approved amendments apply from [insert date].

The decision, approved changes, and further details about the decision made are available from the *Authority* website.

1. *GENERAL*

1.1 INTRODUCTION

(a) This Chapter 1 defines the scope of the *Rules* both as to their content and their application. It provides rules of interpretation and refers to the dispute resolution process. It establishes the obligations of all parties and defines the methods for variations, exemptions, and amendments to these *Rules*.

(b) The objectives of these *Rules* are that they:

(1) are reasonable;

(2) do not impose inappropriate barriers to entry to a market;

(3) are consistent with *good electricity industry practice*; and

(4) are consistent with relevant *written laws* and *statutory instruments*.

1.2 AUTHORISATION

These *Rules* are made under chapter 12 of the *Access Code*. As applicable, they set out:

(a) the required performance standards for service quality in relation to the *power system*;

(b) the technical requirements for the design or operation of equipment *connected* to the *transmission and distribution systems*;

(c) the requirements for the operation of the *transmission and distribution systems* excluding the operation of those parts of the *transmission system* under the control of *AEMO* acting in accordance with the *WEM Rules* except under emergency situations as provided for under the *WEM Rules*;

(d) the obligations of *Users* to test equipment in order to demonstrate compliance with the technical requirements referred to in clause 1.2(b) and the operational requirements referred to in clause 1.2(c);

(e) the procedures that apply if the *Network Service Provider* believes that a *User's* equipment does not comply with the requirements of these *Rules*;

(f) the procedures for the inspection of a *User's* equipment;

(g) the procedures for system tests carried out in relation to all or any part of the *transmission and distribution systems*;

(h) the requirements for control and *protection* settings for equipment *connected* to the *transmission and distribution systems*;

(i) the procedures for the commissioning and testing of new equipment *connected* to the *transmission and distribution systems*;

(j) the procedures for the disconnection of equipment from the *transmission and distribution systems*;

(k) the procedures for the operation of *generation* that is not under the control of *AEMO* but which is *connected*, either directly or indirectly, to the *transmission and distribution systems*;

(l) the information which each *User* is required to provide the *Network Service Provider* in relation to the operation of equipment *connected* to the *transmission and distribution systems* at the *User's connection point* and how and when that information is to be provided;

(m) the requirements for the provision of automatic under *frequency load shedding*;

(n) other matters relating to the *transmission and distribution systems* or equipment *connected* directly or indirectly to the *transmission and distribution systems*; and

(o) the network planning criteria for *transmission and distribution systems*.

1.3 APPLICATION

(a) In these *Rules*, unless otherwise stated, a reference to the *Network Service Provider* refers to the *service provider* for the *South West Interconnected Network*. The *service provider* for the *South West Interconnected Network*, is the Electricity Networks Corporation, a statutory corporation established by the Electricity Corporations Act (2005) (WA).

(b) These *Rules* apply to:

(1) the *Network Service Provider* in its role as the owner and *operator* of the *transmission and distribution systems*;

(2) *AEMO* in its role as *operator* of the *power system* as defined in clause 2.1A of the *WEM Rules*;

(3) *Users* of the *transmission or distribution system* who, for the purposes of these *Rules* include:

(A) every person who seeks *access* to *spare capacity* or *new capacity* on the *transmission or distribution system* or makes an *access application* under the *Access Code* in order to establish a *connection point* or modify an existing *connection*;

(B) every person to whom *access* to the *transmission or distribution system* capacity is made available (including every person with whom the *Network Service Provider* has entered into an *access contract* or *connection agreement*).

1.4 COMMENCEMENT

These *Rules* come into operation on **1 July 2007** (the "*Rules commencement date*"). Where the *Rules* have been amended or revised, the commencement date of each *revision* is the date on the cover page unless otherwise indicated.

1.5 INTERPRETATION

(a) In these *Rules*, the words and phrases defined in Attachment 1 have the meanings given to them there.

(b) These *Rules* must be interpreted in accordance with the rules of interpretation set out in Attachment 1 and Attachment 2.

1.6 THE NETWORK SERVICE PROVIDER AND USERS TO ACT REASONABLY

1.6.1 Importance of objectives

Subject to the *Access Code*, the *Network Service Provider* and *Users* must comply with these *Rules* and act in a manner consistent with the objectives of these *Rules* as set out in clause 1.1(b).

1.6.2 Acting reasonably

(a) The *Network Service Provider* and *Users* must act reasonably towards each other in regard to all matters under these *Rules*.

(b) Whenever the *Network Service Provider* or a *User* is required to make a determination, form an opinion, give approval, make any request, exercise a discretion or perform any act under these *Rules*, it must be formed, given, made, exercised or performed reasonably and in a manner that is consistent with the objectives of these *Rules* and be based on reasonable grounds, and not capriciously or arbitrarily refused, or unduly delayed.

1.7 DISPUTE RESOLUTION

All disputes concerning these *Rules* must be resolved in accordance with Chapter 10 of the *Access Code*.

1.8 OBLIGATIONS

1.8.1 General

(a) *Users* and the *Network Service Provider* must maintain and operate (or ensure their authorised *representatives* maintain and operate) all equipment that is part of their respective *facilities* in accordance with:

(1) relevant laws;

(2) the requirements of the *Access Code*;

(3) the requirements of these *Rules*; and

(4) *good electricity industry practice* and applicable *Australian Standards*.

(b) Where an obligation is imposed under these *Rules* to arrange or control any act, matter or thing or to make sure that any other person undertakes or refrains from any act, that obligation is limited to a requirement to use all reasonable endeavours in accordance with the *Access Code*, to comply with that obligation.

(c) If the *Network Service Provider, AEMO* or a *User* fails to arrange or control any act, matter or thing or the acts of any other person, the *Network Service Provider, AEMO* or *User* is not taken to have breached such obligation imposed under these *Rules* provided the *Network Service Provider, AEMO* or *User* used all reasonable endeavours to comply with that obligation.

1.8.2 Obligations of the *Network Service Provider*

(a) The *Network Service Provider* must comply with the *power system* performance standards described in these *Rules*.

(b) The *Network Service Provider* must:

(1) make sure that, for *connection points* on the *transmission or distribution system* every arrangement for *connection* with a *User* complies with all relevant provisions of these *Rules*;

(2) permit and participate in inspection and testing of *facilities* and equipment in accordance with clause 4.1;

(3) permit and participate in commissioning of *facilities* and equipment in accordance with clause 4.2;

(4) advise a *User* with whom there is an *access contract* of any expected interruption or reduced level of service at a *connection point* so that the *User* may make alternative arrangements for *supply* during such interruptions;

(5) make sure that modelling data used for planning, design and operational purposes is complete and accurate and, where there are grounds to question the validity of data, undertake tests or require *Users* to undertake tests in accordance with clause 4.1;

(6) review and assess *generator performance standards* proposed by *Generators* in accordance with clause 3.3.4; and

(7) maintain a register of performance requirements for *User facilities* as specified in clause 3.2.6.

(c) The *Network Service Provider* must arrange for:

(1) management, maintenance and operation of the *transmission and distribution systems* such that:

(A) when the *power system* is under normal operating conditions electricity may be transferred continuously at a *connection point* up to the *agreed capability* of that *connection point*;

(B) the number and impact of interruptions or service level reductions to *Users* is minimised;

(2) restoration of the *agreed capability* of a *connection point* as soon as reasonably practicable following any interruption or reduction in service level at that *connection point*; and

(3) a recovery or contingency plan to be developed and maintained with respect to the restoration of the *agreed capability* of a *connection point* where the *Network Service Provider* does not hold spare replacement plant.

1.9 VARIATIONS AND EXEMPTIONS FROM THESE RULES

1.9.1 *User* exemptions from these *Rules*

(a) An exemption from compliance with one or more of the requirements of these *Rules* may be granted to a *User* by the *Network Service Provider* in accordance with sections 12.33 to 12.39 of the *Access Code*.

(b) Where an exemption granted under these *Rules* may impact *power system security* or *power system reliability,* the *Network Service Provider* must consult with *AEMO* as appropriate before deciding whether to grant the exemption.

(c) For the avoidance of doubt, no exemption is required when the *Network Service Provider* properly and reasonably exercises a discretion granted to it under these *Rules*.

> **Note:**
> *Generator performance standards* negotiated and agreed in accordance with these *Rules* do not require an exemption where the agreed outcome for each standard is within the minimum and *ideal generator performance standard*.

(d) An application for an exemption must include the relevant supporting information and supporting justifications.

(e) Where an exemption or variation from these *Rules* is granted in accordance with sections 12.33 to 12.39 of the *Access Code*, the *Network Service Provider* must record the exemption or variation.

(f) In accordance with clause A6.2 of the *Access Code*, these *Rules* are not required to address the matters listed in clause A6.1 of the *Access Code* to the extent that these matters are dealt with in Chapters 3, 3A and 3B or Appendices 12 or 13 of the *WEM Rules*.

> **Note:**
> Clause 1.9.1(f) clarifies that *Generators* who negotiate and agree *generator performance standards* under the *WEM Rules* do not need to negotiate these standards in accordance with these *Rules*.

1.9.2 *Network Service Provider* exemptions from these *Rules*

Exemptions from one or more requirements of these *Rules* may be granted to the *Network Service Provider* and all *applicants, Users* and *controllers* of the *transmission and distribution systems* by the *Authority* as set out in sections 12.40 to 12.49 of the *Access Code*.

1.9.3 Amendment to the *Rules*

(a) The *Authority* may amend these *Rules* in accordance with sections 12.50 to 12.54A of the *Access Code*.

1.9.4 Existing equipment and modifications

(a) All *facilities* and equipment in the *transmission and distribution systems*, all *connection assets*, and all *User facilities* and equipment *connected* to the *transmission or distribution system* existing at the *Rules commencement date* are deemed to comply with the requirements of these *Rules*. This also applies to *facilities* in respect of which *Users* have signed a *connection agreement* or projects of the *Network Service Provider* for which work has commenced prior to the *Rules commencement date*.

(b) Subject to clause 1.9.5, all *facilities* and equipment installed after the *Rules commencement date* must comply with the version of the *Rules* in force at:

(1) the time the *facility* or equipment was commissioned, where the *facility* or equipment forms part of the *transmission and distribution systems; or*

(2) the date of the most recent signed *connection agreement* for *User's facilities* and equipment where a *connection agreement* exists, or otherwise the date of commissioning of the *facilities* and equipment.

(c) When equipment is upgraded or modified for any reason, the upgraded or modified equipment must comply with the applicable requirements of these *Rules* in force at the time of the upgrade or modification. This does not apply to other equipment that forms parts of the same *facility*.

(d) The *Network Service Provider* must develop, maintain, and publish guidelines to inform *Users* and provide examples of upgrades and modifications as per clause 1.9.4(c), and *relevant generator modifications*.

1.9.5 Ongoing suitability with the *Rules*

(a) A *User* or the *Network Service Provider* must ensure that the capabilities and ratings of their equipment is monitored on an ongoing basis and must ensure its continued safety and suitability as conditions on the *power system* change.

(b) The *Network Service Provider* may require a *User to:*

(1) demonstrate that their equipment is being monitored on an ongoing basis in accordance with clause 1.9.5(a); and

(2) upgrade or modify their equipment to ensure that *power system* performance standards in clause 2.2 continue to be met under the most recent version of the *Rules*.

(c) Where the *Network Service Provider* requires a *change* under clause 1.9.5(b)(2), the *Network Service Provider* must state the reasons for the request, the timing within which the request must be fulfilled, and may consult with *AEMO*.

2. *TRANSMISSION AND DISTRIBUTION SYSTEM PERFORMANCE AND PLANNING CRITERIA*

2.1 INTRODUCTION

This Chapter 2 describes the technical performance requirements of the *power system*, and the obligations of the *Network Service Provider* to provide the *transmission and distribution systems* that will allow these performance requirements to be achieved. In addition, it sets out criteria for the planning, design and construction of the *transmission and distribution systems*.

Section 2.2 specifies the *power system* performance standards that the *Network Service Provider* seeks to achieve when planning and operating their *transmission and distribution systems* and when negotiating the *connection* of new *Users*.

A *User* should not rely on *power system performance standards* being fully complied with at a *connection point* under all circumstances. During the process of restoring the *power system* from a system shutdown or major *supply* disruption, the *power system* may not meet the *power system* performance standards defined in section 2.2.

2.2 POWER SYSTEM PERFORMANCE STANDARDS

2.2.1 *Frequency* variations

(a) The *frequency operating standards* specified in the *WEM Rules* apply for the *power system* when it is operating as a single interconnected system or as one or more islanded systems created by disconnecting one or more *transmission elements*.

> **Note:**
> An island is formed when the *interconnection* between parts of the *interconnected transmission system* is broken, for example if the *interconnection* between the Goldfields *region* and remainder of the *power system* is broken.

2.2.2 *Transmission voltage*

2.2.2.1 *Voltage* performance timeframes

(a) Each of the following timeframes, illustrated in Figure 2-1, should be considered in assessing *voltages*:

(1) **Transient phase** extends for 5 seconds to 10 seconds following a relevant switching event or *credible contingency*. This timeframe allows for *protection* operations to clear any fault, automated *Generator* tripping schemes, *load* response to *voltage* changes and the response of fast acting *voltage* control devices including automatic *voltage* regulators on *generating systems, SVCs* and STATCOMs.

(2) **Time Phase 1** extends from the end of the transient phase to 30 seconds after a relevant switching event or *credible contingency*. During this time, delayed auto-reclosing of *transmission* and *distribution* lines occur.

(3) **Time Phase 2** extends from 30 seconds to 3 minutes after a relevant switching event or *credible contingency*. During this time *zone substation transformers* may be tapped via automatic *voltage* controllers, automatic switching of *reactors* and capacitors may occur and all *loads* that remain *connected* to the

power system are expected to be restored to the level that existed prior to the switching event or *credible contingency*.

(4) **Time Phase 3** extends from 3 minutes to 20 minutes after a relevant switching event or *credible contingency.* During this time manual adjustments to, and switching of, equipment may occur. For example, switching of *reactors* or capacitors, and adjustment of *transformer* tap changers, *generating systems* or other *reactive equipment*.

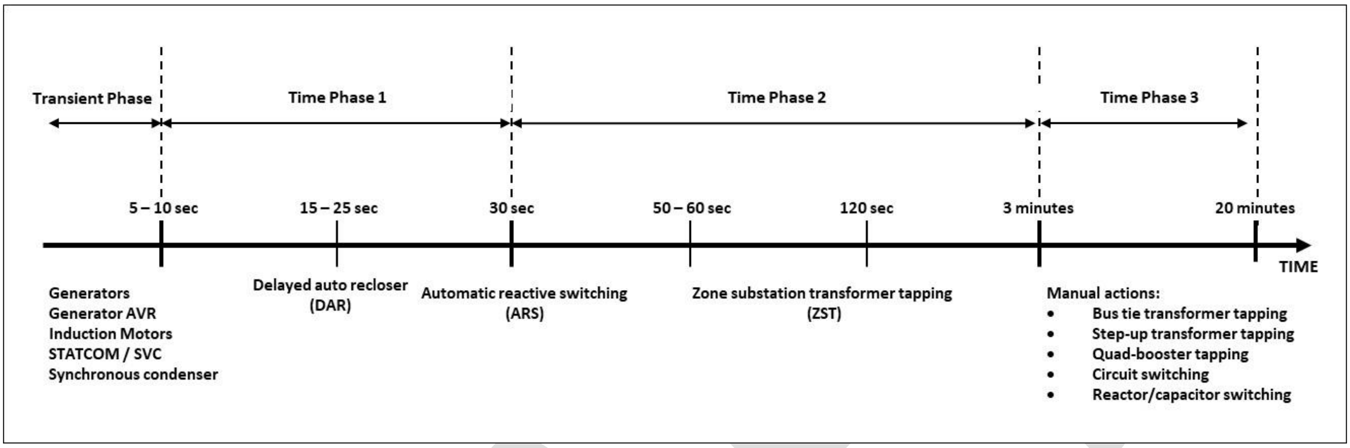

Figure 2-1 Timeframes for the assessment of *voltage* performance

2.2.2.2 *Transmission voltage* criteria

(a) A *voltage* condition is unacceptable if:

(1) there is any inability to achieve pre-event *steady state voltages* on the *transmission system* within the limits specified in Table 2-1, or

(2) after either operational switching or a *credible contingency,* the affected site remains *connected* to the *transmission system* and any of the following conditions apply:

(i) the *voltage step change* at a *User connection point* exceeds that specified in Table 2-2;

(ii) there is any inability following such an event to achieve a *steady state voltage* on the *transmission system* as specified in Table 2-3 using manual and/or automatic *facilities* available, including the switching in or out of relevant equipment, with the assessment made at the end of time phase 3.

2.2.2.3 *Transmission* pre-event *voltage* limits in all timescales

(a) The *steady state voltage* at all points on the *transmission system* must not exceed the limits specified in Table 2-1 prior to any switching event or *credible contingency*.

Table 2-1 *Transmission system* pre-event *steady state voltage* limits

Nominal *voltage*	*Planning timescale voltage* limits	*Operational timescale voltage* limits
330 kV	+4% / -4%	+10% / -10%
220 kV	+4% / -4%	+10% / -10%
132 kV	+5% / -5%	+10% / -10%
66 kV	+5% / -5%	+10% / -10%

(b) The *planning timescale voltage* limits may be relaxed to meet *power transfer* requirements if the *Network Service Provider* assesses that there is sufficient certainty of meeting the *voltage* limits specified for *operational timescales*.

2.2.2.4 *Transmission voltage step change* limits in all timescales

(a) The *voltage step change* resulting from switching operations and *credible contingencies* on the *transmission system* must not exceed the limits given in Table 2-2 at *User connection points* that remain *connected* to the *transmission system* and connections to the *distribution system*.

Table 2-2 *Transmission voltage step change* in all timescales

Event	Post-event *voltage* step (% of nominal *voltage*)
frequent operational switching	+/- 3%
infrequent operational switching	+6% / -10%
credible contingency	+6% / -10%

2.2.2.5 *Transmission* post-event *voltage* limits in all timescales

(a) The *voltage* limits in Table 2-3 are to be observed following the specified event and at the end of time phase 3 as defined in clause 2.2.2.1 (and shown in Figure 2-1).

Table 2-3 Post-event steady state *transmission voltage* limits in all timescales

Nominal *voltage*	Event	*Planning timescale* limits (% of nominal *voltage*)	*Operational timescale* limits (% of nominal *voltage*)
330kV	*frequent operational switching*	+4% / -4%	+10% / -10%
	infrequent operational switching	+4% / -4%	+10% / -10%
	credible contingency	+6% / -6%	+10% / -10%
220kV	*frequent operational switching*	+4% / -4%	+10% / -10%
	infrequent operational switching	+4% / -4%	+10% / -10%
	credible contingency	+6% / -6%	+10% / -10%
132kV	*frequent operational switching*	+5% / +5%	+10% / -10%
	infrequent operational switching	+5% / +5%	+10% / -10%
	credible contingency	+7% / -7%	+10% / -10%
66kV	*frequent operational switching*	+5% / +5%	+10% / -10%
	infrequent operational switching	+5% / +5%	+10% / -10%
	credible contingency	+7% / -7%	+10% / -10%

2.2.2.6 *Transmission* transient overvoltage limits

(a) As a consequence of a switching event or *credible contingency* the *voltage* at all locations on the *transmission system* must remain within the overvoltage envelope shown in Figure 2-2.

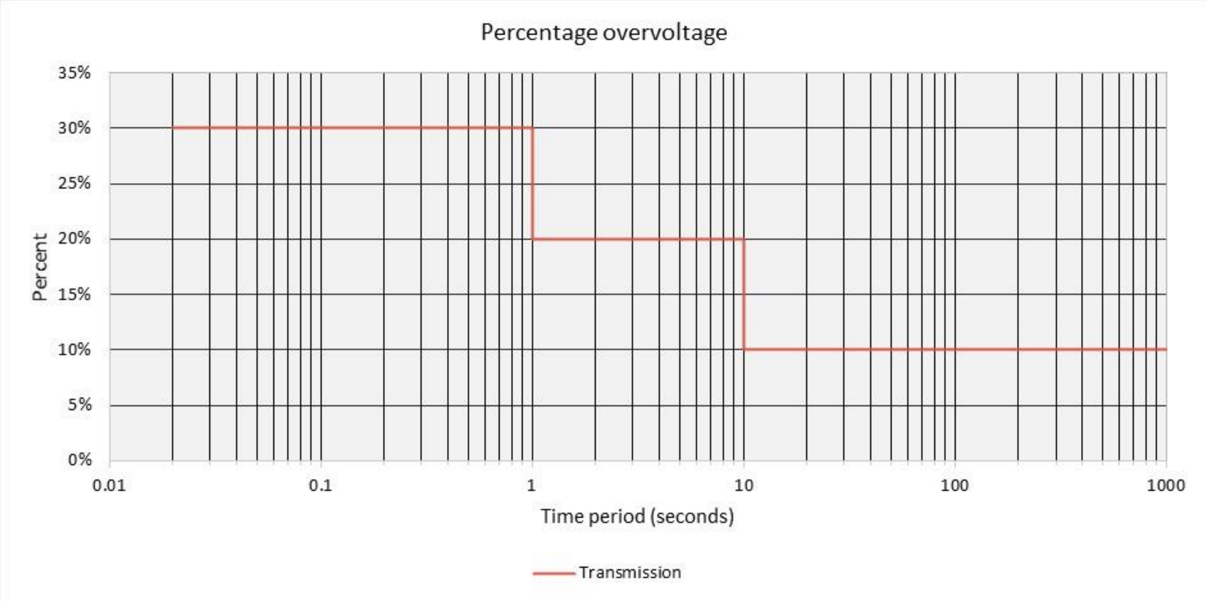

Figure 2-2 Highest acceptable level and duration of AC transient overvoltage on the *transmission system*

> **Note:**
> In Figure 2-2, the percentage *voltage* level refers to the nominal *voltage* and the *voltage* is the RMS phase to phase *voltage*.

2.2.2.7 *Transmission* transient undervoltage limits

(a) A *credible contingency* shall not result in the *voltage* at a *generation connection point* that remains connected to the *transmission system* exceeding the registered capability of the *generator*.

(b) *Infrequent operational switching*, such as *transformer energisation*, shall not result in the *voltage User connection points* to the *transmission system*:

(1) subject to clause 2.2.2.7(c), falling below 80% of the nominal *voltage*;

(2) remaining below 90% of the nominal *voltage* for more than 1 second after the switching event.

(c) Following *infrequent operational switching*, the *voltage* at *User connection points* to the *transmission system* may be allowed to fall below 80% of the nominal *voltage* for 100 ms after the switching event but must remain above 70% of the nominal *voltage* for this period provided there are economic efficiencies and no *Users* of the system are reasonably expected to be adversely affected.

(d) The required *voltage* performance under clause 2.2.2.7(b) and 2.2.2.7(c) should be assessed via the appropriate combination of RMS and *EMT* analysis. Typically, *voltages* during transient timescales:

(1) following motor starting will be assessed via RMS analysis and should comply with IEC 61000.3.7 section 10;

(2) following energisation of *transformers* and switching of lines will be assessed via *EMT* analysis and evaluated according to the *voltage* on individual phases.

2.2.3 *Distribution voltage*

2.2.3.1 *Distribution steady state voltage* limits

(a) Except as a consequence of a non-*credible contingency*, the minimum *steady state voltage* on those parts of the *distribution system* operating at *voltages* above 1 kV must be 90% of nominal *voltage* and the maximum *steady state voltage* must be 110% of nominal *voltage*.

(b) For the *low voltage distribution system*, the *steady state voltage* must be within:

(1) ±6% of the nominal *voltage* during normal operating conditions,

(2) ±8% of the nominal *voltage* during *maintenance conditions*,

(3) ±10% of the nominal *voltage* during *emergency conditions*.

(c) Where more precise control of the *distribution voltage* is required than is provided for under this clause 2.2.3.1, a target range of *voltage* magnitude at a *connection point* may be agreed with a *User* and specified in a *connection agreement*. Where:

(1) more than one *User* is supplied at a *connection point* such that independent control of the *voltage* supplied to an individual *User* at that *connection point* is not possible, a target must be agreed by all relevant *Users* and the *Network Service Provider;*

(2) *voltage* magnitude targets are specified in a *connection agreement, Users* should allow for short periods where *voltages* vary from the target values by 5%, in the design of their *equipment*.

2.2.3.2 *Distribution system voltage step change* limits

(a) The *voltage step change* resulting from switching operations and *credible contingencies* on the *distribution system* must not exceed the limits given in Table 2-4 at *User connection points* that remain connected to the *distribution system*.

(b) *Credible contingencies* for the purpose of assessing *distribution system voltage step change* limits are restricted to the tripping of *generating units* within *User facilities.*

Table 2-4 *Distribution voltage step change* limits

Event	**Post-event *voltage step change*(4) (% of nominal *voltage*)**
Planned routine switching(1)	+/- 4.0%
Planned infrequent switching(2)	+6 % / -10%
Credible contingency(3)	+6% / -10%

Notes:

(1) For example, capacitor or *reactor* switching, *transformer* tap action, motor starting, start-up and shutdown of *generating units*, change in operating state of *electricity storage facilities*.

(2) Infrequent *User facility* switching occurring less than once per hour.

(3) As per clause 2.2.3.2(b), *credible contingencies* are limited to tripping of *generating units* within *User facilities*.

(4) If necessary, *loads* may be *disconnected* to avoid exposing them to post tapping *voltages* that exceed +10% of the nominal *voltage*.

2.2.3.3 *Distribution* transient overvoltage limits

(a) As a consequence of a switching event or *credible contingency* the *voltage* at:

(1) all locations in the *distribution system* operating at *voltages* greater than 1 kV must remain within the overvoltage envelope shown in Figure 2-3, and

(2) all locations in the *low voltage distribution system* must remain within the overvoltage envelope shown in Figure 2-4.

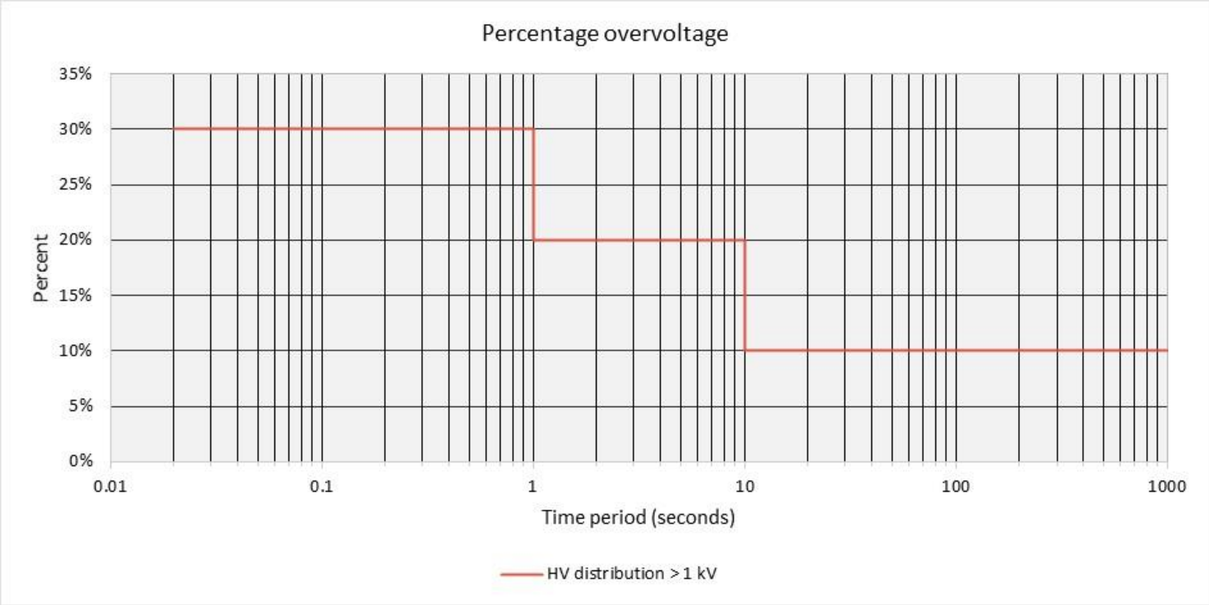

Figure 2-3 Highest acceptable level and duration of AC transient overvoltage on the *distribution system* operating above 1 kV

Note:
In Figure 2-3 the percentage *voltage* level refers to either the nominal *voltage* or the mid-point of the target *voltage* range for a *connection point*, where such a range has been set in accordance with clause 2.2.3.1(c). For this clause, the *voltage* is the RMS phase to phase *voltage*.

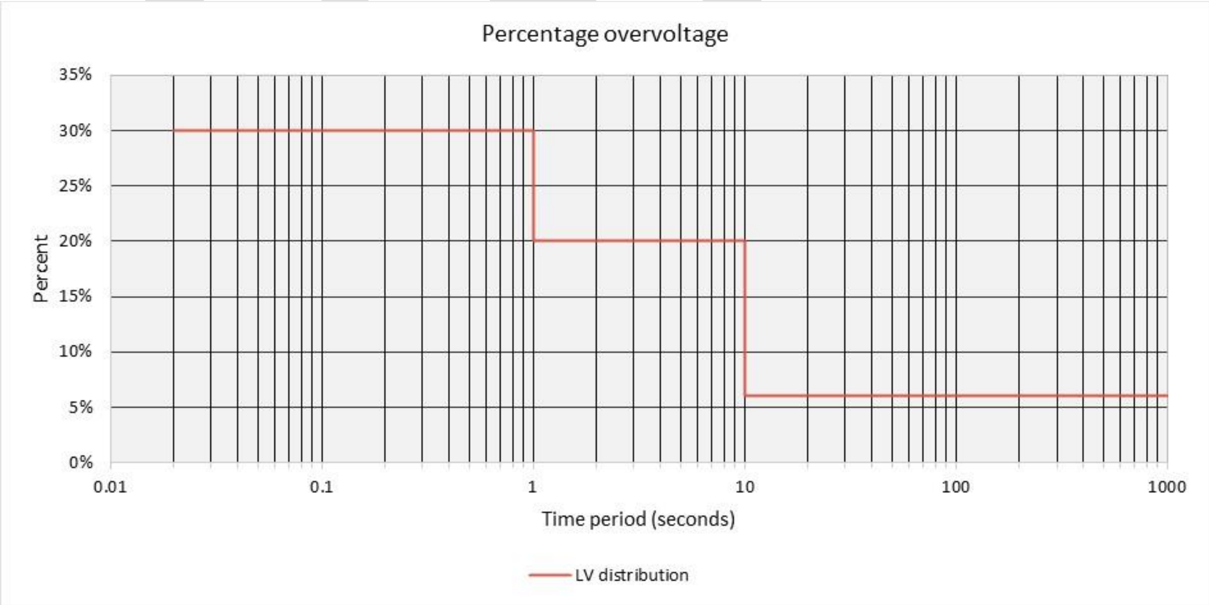

Figure 2-4 Highest acceptable level and duration of AC transient overvoltage on the *low voltage distribution system*

2.2.4 Flicker

(a) Rapid *voltage* fluctuations cause changes to the luminance of lamps which can create the visual phenomenon called flicker. Flicker severity is characterised by the following two quantities, which are defined in AS/NZS 61000.3.7 (2001):

(1) P_{st} – short-term flicker severity term (obtained for each 10 minute period);

(2) P_{lt} – long-term flicker severity (obtained for each 2 hour period).

(b) Under normal operating conditions, flicker severity caused by *voltage* fluctuation in the *transmission and distribution system* must be within the planning levels shown in Table 2-5 for 99% of the time.

Table 2-5 Planning levels for flicker severity

Flicker Severity Quantity	*LV* (415 V)	*MV* (≤ 35 kV)	*HV*-EHV (> 35 kV)
P_{st}	1.0	0.9	0.8
P_{lt}	0.65	0.7	0.6

Notes:

1. These values were chosen on the assumption that the transfer coefficients between *MV* or *HV* systems and *LV* systems are unity. The planning levels could be increased in accordance with AS 61000.3.7 (2001).

2. The planning levels in Table 2-5 are not intended to apply to flicker arising from *contingency events* and other uncontrollable events in the *power system*.

2.2.5 Harmonics

Under normal operating conditions, the harmonic *voltage* in the *transmission and distribution systems* must not exceed the planning levels shown in Table 2-6 and Table 2-7 (as applicable) appropriate to the *voltage* level, whereas the interharmonics *voltage* must not exceed the planning levels set out in *AS*/NZS 61000.3.6 (2001).

Table 2-6 *Distribution* planning levels for harmonic *voltage* in networks with system *voltage* less than or equal to 35 kV (in percent of the nominal *voltage*)

Odd harmonics non-multiple of 3		Odd harmonics multiple of 3		Even harmonics	
Order h	Harmonic *voltage* %	Order h	Harmonic *voltage* %	Order h	Harmonic *voltage* %
5	5	3	4	2	1.6
7	4	9	1.2	4	1
11	3	15	0.3	6	0.5
13	2.5	21	0.2	8	0.4
17	1.6	>21	0.2	10	0.4
19	1.2			12	0.2
23	1.2			>12	0.2
25	1.2				
>25	$0.2 + 0.5\frac{25}{h}$				
Total harmonic distortion (THD): 6.5 %					

Table 2-7 *Transmission* planning levels for harmonic *voltage* in networks with system *voltage* above 35 kV (in percent of the nominal *voltage*)

Odd harmonics non-multiple of 3		Odd harmonics multiple of 3		Even harmonics	
Order h	Harmonic *voltage* %	Order h	Harmonic *voltage* %	Order h	Harmonic *voltage* %
5	2	3	2	2	1.5
7	2	9	1	4	1
11	1.5	15	0.3	6	0.5
13	1.5	21	0.2	8	0.4
17	1	>21	0.2	10	0.4
19	1			12	0.2
23	0.7			>12	0.2
25	0.7				
>25	$0.2 + 0.5\frac{25}{h}$				
Total harmonic distortion (THD): 3 %					

Notes:

1. The planning levels in Table 2-6 and Table 2-7 are not intended to apply to harmonics arising from uncontrollable events such as geomagnetic storms, etc.
2. The total harmonic distortion (THD) is calculated from the formula:

$$THD = \frac{U_{nom}}{U_1}\sqrt{\sum_{h=2}^{40}(U_h)^2}$$

where:

U_{nom} = nominal *voltage* of a system;

U_1 = fundamental *voltage*;

$U_{h\ q}$ = harmonic *voltage* of order *h* expressed in percent of the nominal *voltage*.

3. Table 2-6 and Table 2-7 are consistent with AS 61000 (2001).

2.2.6 Negative phase sequence *voltage*

The 10 minute average level of negative phase sequence *voltage* at all *connection points* must be equal to or less than the values set out in Table 2-8.

Table 2-8 Limits for negative phase sequence component of *voltage* (in percent of the positive phase sequence component)

Nominal system *voltage* (kv)	**Negative sequence *voltage* (%)**
> 100	1
10 – 100	1.5
< 10	2

2.2.7 Electromagnetic interference

Electromagnetic interference caused by equipment forming part of the *transmission and distribution system* must not exceed the limits set out in Tables 1 and 2 of *AS*/NZS 2344 (2016).

2.2.8 Transient stability

The *power system* must be planned to ensure disturbances on the *transmission or distribution systems* caused by a *credible contingency*, following a *credible fault event*, shall not exceed the performance requirements of any *generating system*.

Transient stability is achieved if the *power system* is able to reach an acceptable steady state condition following a disturbance.

2.2.9 Oscillatory stability

(a) The *power system* must be *adequately damped* after system oscillation triggered by a *small disturbance* or a *large disturbance*.

(b) A system oscillation triggered by any *small disturbance* or *large disturbance* shall conform to the following criteria:

(1) the *damping ratio* of the oscillation must be at least 0.1;

(2) the *halving time* of any oscillation is not to exceed 5 seconds; and

(3) allow *Generator*s to maintain *continuous uninterrupted operation*.

Note:
A *halving time* ≤ 5 seconds is equivalent to a damping coefficient –0.14 nepers per second or less.

(c) To assess the damping of *power system* oscillations during operation, or when analysing results of tests such as those carried out under clauses 4.1.3, 4.1.7 and 5.7.6, the *Network Service Provider* must take into account statistical effects. Therefore, the *power system* damping operational performance criterion is that at a given operating point, real-time monitoring or available test results show that there is less than a 10 percent probability that the *halving time* of the least damped mode of oscillation will exceed ten seconds, and that the average *halving time* of the least damped mode of oscillation is not more than five seconds.

2.2.10 *Voltage stability*

(a) The *power system* must achieve *voltage stability* for any disturbance resulting from a *credible contingency*. For all *credible contingencies,* the criteria set out in clauses 2.2.2 and 2.2.3 must be met to ensure *voltage stability*.

(b) There must be sufficient static and dynamic *reactive power* capability available to maintain *steady state voltage* control allowing for credible variations in *load* and *generation* patterns and reasonable variations in the availability of *reactive equipment.*

2.3 OBLIGATIONS OF NETWORK SERVICE PROVIDER IN RELATION TO POWER SYSTEM PERFORMANCE

2.3.1 Flicker

(a) To ensure that the flicker level at any *point of common coupling* on the *transmission or distribution system* does not exceed the maximum levels specified in clause 2.2.4, the *Network Service Provider* must, where necessary and after consultation with the relevant *Users,* allocate flicker emission limits to *Users* in accordance with clauses 2.3.1(b) and 2.3.1(c).

(b) The *Network Service Provider* must allocate contributions to limits no more onerous than the lesser of the acceptance levels determined in accordance with the stage 1 and the stage 2 evaluation procedures defined in *AS*/NZS 61000.3.7 (2001).

(c) If the *User* cannot meet the contribution calculated by using the method of clause 2.3.1(b), then the *Network Service Provider* may use, in consultation with the party seeking *connection,* the stage 3 evaluation procedure defined in *AS*/NZS 61000.3.7 (2001).

(d) The *Network Service Provider* must verify compliance of *Users* with allocated flicker emission levels. The contribution may be assessed by direct measurement or by calculation from the available data for the *load* and the *power system*. In verifying compliance, measurements of flicker must be carried out according to *AS*/NZS 61000.3.7 (2001).

2.3.2 Harmonics

(a) To ensure that the harmonic or interharmonic level at any *point of common coupling* on the *transmission or distribution system* does not exceed the maximum levels specified in clause 2.2.5, the *Network Service Provider* must, where necessary and after consultation with the relevant *Users,* allocate harmonic emission limits to *Users* in accordance with *AS*/NZS 61000.3.6 (2001).

(b) The *Network Service Provider* must verify compliance of *Users* with allocated harmonic or interharmonic emission levels. The contribution may be assessed by direct measurement or by calculation from the available data for the *User's facility* and the *power system*.

(c) The measurement must be carried out according to *AS*/NZS 61000.4.7 (1999). Harmonics must generally be measured up to h=40. However, higher order harmonics up to 100th order may be measured if the *Network Service Provider* reasonably considers them to be of material concern.

2.3.3 Negative phase sequence *voltage*

(a) If the maximum level of negative phase sequence *voltage*, as specified in Table 2-8, is exceeded at any *connection point* on the *transmission or distribution system*, the *Network Service Provider* must remedy the problem to the extent that it is caused by the *transmission and distribution systems*.

(b) If, in the *Network Service Provider's* opinion, the problem is caused by an unbalance in the phase currents within a *User's* equipment or *facilities,* it must require the *User* to remedy the unbalance.

2.3.4 Electromagnetic interference

The *Network Service Provider* must respond to all complaints regarding electromagnetic interference in a timely manner and undertake any necessary tests to determine whether or not the interference is caused by equipment forming part of the *transmission and distribution systems*, and whether or not it exceeds the limits specified in clause 2.2.7. If the complaint is substantiated by tests, the *Network Service Provider* must, as soon as reasonably practicable, take any necessary action to reduce the interference to below the maximum prescribed levels.

2.3.5 ***Power system stability* and *dynamic performance***

2.3.5.1 Stability and modelling guidelines

(a) The *Network Service Provider* must develop, publish and maintain ‘Generator and Load Model Guidelines’.

(b) The ‘Generator and Load Model Guidelines’ should clarify:

(1) the *Network Service Provider’s* approach to developing and maintaining accurate computer models; and

(2) the requirements for *Users* to provide computer models and associated information for new *connections* or modifications to existing *facilities*.

(c) The ‘Generator and Load Model Guidelines’ should be consistent with the generation system model procedure specified in clause 3A.4.2 of the *WEM Rules.*

2.3.5.2 Stability and modelling obligations

(a) The *Network Service Provider* must plan, design and construct the *transmission and distribution systems* so that the *power system stability* criteria specified in clauses 2.2.8 to 2.2.10 are met for credible system *load* and *generation* patterns, and the most critical, for the particular location, *credible contingency* without exceeding the rating of any *power system* component or, where applicable, the allocated *power transfer* capacity.

(b) The *Network Service Provider* should ensure that simulation completed to assess *power system stability* appropriately consider both the short-term and longer-term response of the *power system* to *credible contingencies*.

(c) To ensure compliance with clause 2.3.5.2(a), the *Network Service Provider* must simulate the *dynamic performance* of the *power system*. Dynamic models of individual components must be verified and documented in accordance with the ‘Generator and Load Model Guidelines’.

2.3.5.3 Validation of modelling results

(a) The *Network Service Provider* must take all reasonable steps to ensure that the results of the simulation and modelling of the *power system* in accordance with the requirements of clauses 2.3.5.2 and Chapter 3 are valid. This may include *power system* and plant performance tests in accordance with section 4.1.

2.3.6 Determination of *power transfer* limits

(a) The *Network Service Provider* must determine *power transfer* limits for equipment forming part of the *transmission and distribution systems*.

(b) The *power transfer* limits must be expressed as limits advice developed in accordance with the procedure defined in clause 2.27A.11 of the *WEM Rules* and provided to *AEMO* as specified in the clause 2.27A of the *WEM Rules*.

2.3.7 Monitoring and assessment of *power system* performance

(a) The *Network Service Provider* must monitor the performance of the *power system* on an ongoing basis and ensure that the *transmission and distribution systems* are augmented as necessary so that the *power system* performance standards specified in section 2.2 continue to be met irrespective of changes in the magnitude and location of *connected loads* and *generating units*.

(b) The *Network Service Provider* must ensure that system performance parameter measurements to ensure that the *power system* complies with the performance standards specified in clauses 2.2.1 to 2.2.6 are taken as specified in Table 2-9. Records of all test results must be retained by the *Network Service Provider* and made available to the *Authority* or *AEMO* on request.

Table 2-9 Power quality parameters measurement

Parameter	Value measured	Frequency of measurement	Minimum measurement period	Data sampling interval
Fundamental *Frequency*	mean value over interval	Continuous	all the time	10 seconds
Power-*frequency voltage* magnitude	mean rms value over interval	In response to a complaint, or otherwise as required by the *Network Service Provider*.	one week	10 minutes
Short-term flicker severity	P_{st}	In response to a complaint, or otherwise as required by the *Network Service Provider*.	one week	10 minutes
Long-term flicker severity	P_{lt}	In response to a complaint, or otherwise as required by the *Network Service Provider*.	one week	2 hours
Harmonic / interharmonic *voltage* and *voltage* THD	mean rms value over interval	In response to a complaint, or otherwise as required by the *Network Service Provider*.	one week	10 minutes
Negative sequence *voltage*	mean rms value over interval	In response to a complaint, or otherwise as required by the *Network Service Provider*.	one week	10 minutes

Notes:

1. The power quality parameters, except fundamental *frequency* and negative sequence *voltage*, must be measured in each phase of a three-phase system.
2. The fundamental *frequency* must be measured based on line-to-neutral *voltage* in one of the phases or line-to-line *voltage* between two phases.
3. Other parameters and data sampling intervals may be used to assess the *Network Service Provider's transmission and distribution system* and *User* system performance during specific events.

(c) The *Network Service Provider* must ensure that sufficient monitoring is in place to assess the performance of the *power system* against the performance standards specified in clause 2.2. Monitoring systems should be capable of assessing whether power quality standards are being achieved at key locations across the network and capturing the dynamic response of the *power system* to disturbances with sufficient resolution to confirm that the *power system stability* and *system strength* requirements are being achieved.

2.3.8 System restart capability

(a) The *Network Service Provider* must provide any assistance sought by *AEMO* to develop the *SWIS restart plan*.

(b) The *Network Service Provider* must plan the network to provide the capability required to restart the *power system* in accordance with the *SWIS restart plan* developed by *AEMO*.

(1) The *transmission and distribution systems* should be designed to provide sufficient switching capability to enable the establishment of restart pathways identified in the *SWIS restart plan*.

(2) The *Network Service Provider* should consider the expected times to resupply *substations* following a system shutdown when designing *substation* plant and equipment (e.g., batteries used for communication, secondary systems and protection devices).

2.3.9 *System strength*

(a) The *Network Service Provider* must plan and develop the *transmission and distribution systems* to maintain *system strength* in accordance with the *WEM Rules.*

Note:
The intention of clause 2.3.9(a) is to enable the *Network Service Provider* to invest network solutions as well as trigger processes in the *WEM Rules* for the procurement of *non-co-optimised essential system services* to maintain *system strength*.

When fulfilling the obligations in clause 2.3.9(a),the *Network Service Provider* should continue to consider the stability requirements in clauses 2.2.8, 2.2.9 and 2.2.10 and the protection requirements set out in section 2.9 of these *Rules* and should align with any relevant procedures developed by *AEMO* under the *WEM Rules.*

(b) Where a *non-co-optimised essential system service* is to be used to maintain *system strength*, the *Network Service Provider* must request the *Co-ordinator of Energy* to trigger the procurement process in accordance with sections 3.11A and 3.11B of the *WEM Rules*.

2.4 LOAD SHEDDING REQUIREMENTS

(a) The *Network Service Provider* must develop and maintain an automatic under *frequency load shedding* system that complies with the *UFLS Specification Document* developed in accordance with clause 3.6.6 of the *WEM Rules*.

(b) The *Network Service Provider* may require *Users* to make a portion of their *load* available for automatic under *frequency* or under *voltage load shedding,* or both. The *Network Service Provider* may require a *User* to provide control and *monitoring equipment* for the *load shedding* facilities. The amount of *load* available to be shed and the *frequencies* or *voltages* or both at which *load* must be shed must be specified in the relevant *connection agreement*.

2.5 TRANSMISSION SYSTEM PLANNING CRITERIA

2.5.1 Application

Section 2.5 sets out the *transmission system planning criteria.* The *Network Service Provider* must design the *transmission system* in accordance with the applicable *transmission system planning criteria* described below.

Note:
The *transmission system planning criteria* represents the minimum requirements for the planning and operation of the *SWIS* as will typically apply in most situations. In many cases, the standard ratings of *transmission equipment* will result in *transmission* capacity in excess of the minimum requirements outlined in the criteria. Where this is the case, it is not expected that the *transmission capacity* will be reduced such that it only meets the minimum requirement of those criteria. For example, it may not be beneficial to reduce the ratings of overhead lines to reflect lower loading levels that have arisen due to changes in *generation* or demand patterns.

2.5.2 Overview and general requirements

(a) The *transmission system planning criteria* is presented according to the functional parts of the *transmission system*. These parts are the *generation* connections, the *demand* connections, the *sub transmission system*, and the *Main Interconnected Transmission system* (or *MITS*). These parts are illustrated schematically in Figure 2-5.

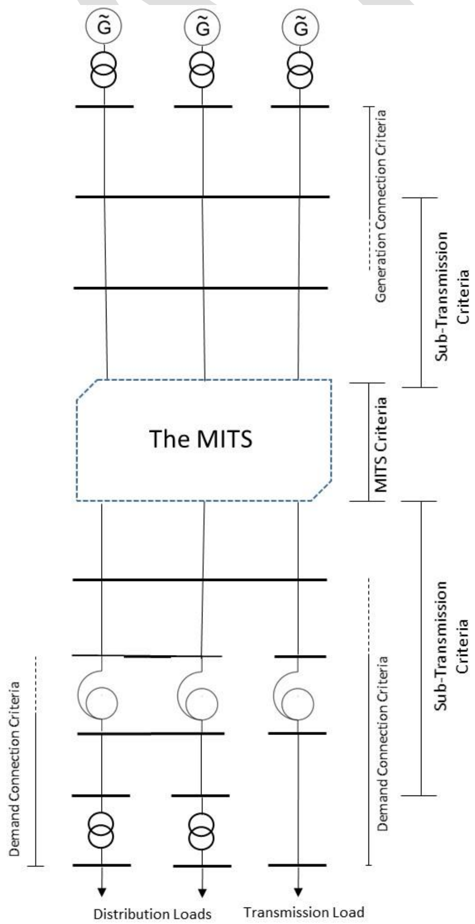

Figure 2-5 Overview of *Main Interconnected Transmission system* with *Generator* and Demand Connections

(b) In the context of the *SWIS*, the *MITS* comprises:

(1) all 330 kV *terminal stations* and *transmission circuits connected* to the 330 kV network by three or more 330 kV circuits;

(2) all *terminal stations* providing direct connection to *generation* in excess of 600 MW; and

(3) the *transmission circuits* connecting *terminal stations* in 2.5.2(b)(2) to the *transmission elements* specified in 2.5.2(b)(1).

(c) In the context of the *SWIS*, *sub transmission system* means any part of the *transmission system* that is not part of the *MITS*.

(d) In the context of the *SWIS*, *generation* connection means the assets connecting *generation* to the *transmission system*.

(e) In the context of the *SWIS*, demand connection means the assets connecting demand to the *transmission system*.

(f) More than one set of planning criteria may apply to parts of the *transmission system,* where this occurs all applicable planning criteria must be met.

Note:
As illustrated in Figure 2-5, there will be parts of the *SWIS* where more than one set of planning criteria applies. In such places the requirements of all relevant criteria must be met. An example is where sites are composite and have a mixture of demand and *generation* connections. In this case, the security afforded to the demand and *generation* connection elements shall be not less than that provided for a typical demand or *generation* connection of an identical size.

(g) The *Network Service Provider* may design to standards **higher** than those set out in clauses 2.5.4 (Demand connection planning criteria) and 2.5.5 (*Main Interconnected Transmission* System and *sub transmission system* planning criteria), provided the higher standards can be economically justified and the potential *power system security* and *power system reliability* effects of the higher standard have been considered.

(h) The *Network Service Provider* may design to standards **lower** than those set out in clause 2.5.4 (Demand connection planning criteria) provided the lower standards can be economically justified and the potential *power system security* and *power system reliability* effects of the lower standard have been considered.

Note:
An example of when the *Network Service Provider* may design to standards lower than those set out in the demand connection planning criteria include the 220 kV line supplying the Eastern Goldfields *region*. An *unplanned outage* on this 220 kV line may result in a loss of supply to the Eastern Goldfields *region*. However, arrangements are in place with local generation to supply the Kalgoorlie-Boulder city and Coolgardie town *loads* during such an outage.

It may also be prudent to design to lower standards when providing supply for remote townships.

(i) Guidance on economic justification applicable to clauses 2.5.2(g) and 2.5.2(h) is given in Attachment 13.

(j) The *Network Service Provider* must develop and review at least every three years, a guideline (the Transmission Planning Guideline) that sets out (but is not limited to):

(1) the application of the requirements in clause 2.5 of these *Rules*, including:

(A) general guidance on the planning of the functional parts of the *transmission system* (i.e., the *generation* connections, the *demand* connections, the *sub transmission system* and the *MITS*);

(B) background conditions that apply for the *MITS* and *sub transmission system* and considerations for background conditions applicable to planning of *generation* connections and *demand* connections;

(C) consideration of contingency criteria as applicable for planning of each functional part of the *transmission system* (i.e., the *generation* connections, the *demand* connections, the *sub transmission system* and the *MITS*);

(2) the application of the *power system* performance standards set out in clause 2.2 of these *Rules* for planning purposes.

(k) The *Network Service Provider* must develop and consult, as needed, with *AEMO* the *generation dispatch* used in *planning timescales*, including with consideration of the relevant sections of the guideline (the Transmission Planning Guideline) developed by the *Network Service Provider* in accordance with clause 2.5.2(j) of these *Rules*.

(l) Any short term equipment ratings or contingency plans and actions that are used by the *Network Service Provider* to maintain compliance with the criteria detailed in the *transmission system planning criteria* must be maintained up to date, functional and able to be delivered within the required *operational timescales*.

2.5.3 *Generation* connection planning criteria

This section presents the planning criteria applicable to the connection of one or more *Generators* to the *SWIS*. The criteria in this section also applies to *Users connected* to the *transmission system* with embedded *generation*.

2.5.3.1 Limits to power infeed loss risk

(a) The *loss of power infeed* resulting from a *credible contingency* on the *transmission system* shall be calculated as follows:

(1) the sum of the capacities of the *generating units* disconnected from the *power system* by the *credible contingency*, plus

(2) the planned import from any external systems disconnected from the *power system* by the same event, less

(3) the forecast minimum demand disconnected from the *power system* by the same event but excluding:

(A) any demand that may be automatically tripped for *frequency* control purposes on the *power system;* and

(B) the demand of the largest single *User* within the group.

(b) The *infeed loss risk limit* is the maximum allowable *loss of power infeed*, to remain within the *Frequency Operating Standard* as defined in the *WEM Rules*. Subject to clause 2.5.3.1(c), for the purposes of *transmission system* design and planning, the maximum *infeed loss risk limit* is 400 MW.

(c) Where a proposed connection or network *augmentation* results in a *loss of power infeed* greater than 400 MW, the higher *loss of power infeed* must be analysed and approved by the *Network Service Provider* in consultation with *AEMO*.

(d) *Generation* connections shall be planned such that, starting with an *intact system* during the *planned outage* of any single section of the *Network Service Provider's busbar*, no reduction of *generation* capacity greater than 150 MW shall occur.

(e) *Generation* connections shall be planned such that, starting with an *intact system* following a *credible contingency* of:

(1) any single *transmission circuit* (including those that result in the associated tripping of any other *transmission circuits* as part of a designed *protection scheme*), single *generation circuit*, single section of *busbar*, the *loss of power infeed* shall not exceed the *infeed loss risk limit*;

(2) any single *busbar* coupler circuit breaker or *busbar* section circuit breaker the *loss of power infeed* shall not exceed the *infeed loss risk limit*;

(3) any single *transmission circuit* or single section of *busbar* during the *planned outage* of any other single *transmission circuit* or single section of *busbar*, the *loss of power infeed* shall not exceed the *infeed loss risk limit*; and

(4) any single *busbar* coupler circuit breaker, or *busbar* section circuit breaker during the *planned outage* of any *transmission circuit*, single section of *busbar*, the *loss of power infeed* shall not exceed the *infeed loss risk limit*.

2.5.3.2 Background conditions

(a) The connection of a *Generator* shall meet the criteria set out in clause 2.5.3.1 under the following background conditions:

(1) the *active power* output of the *Generator* shall be set equal to its *rated maximum active power*. For the purpose of *power system stability* studies, the *active power* output level and *power factor* should be set to the level that provides the lowest level of damping for oscillations;

(2) the *reactive power* output of the *Generator* shall be set to the full leading or lagging output that corresponds to an *active power* output equal to its *rated maximum active power*. For the purpose of assessment of *power system stability* and *voltage* control issues, the *reactive power* output should be set to the level that may reasonably be expected under the conditions described in clause 2.5.3.2(a)(3);

(3) conditions on the *transmission system* shall be set to those reasonably expected to arise in the course of a year of operation. Such conditions shall include forecast demand assumptions, *generation dispatch* and *planned outage* patterns.

2.5.3.3 Pre-fault criteria with an *intact system* or *local system outage*

(a) The *transmission capacity* for a *Generator* connection shall be planned such that for the background condition of an *intact system* or *local system outage* there must be no:

(1) equipment loadings exceeding *pre-fault ratings*;

(2) *unacceptable voltages conditions*; or

(3) *system instability*.

2.5.3.4 Post-fault criteria with *intact system*

(a) *Transmission capacity* for a *generation* connection shall be planned such that for the background conditions described in clause 2.5.3.2(a) and following the *credible contingency* of a *fault outage* on the *transmission system* of:

(1) a single *transmission circuit*;

(2) a single *zone substation transformer*;

(3) a single *generation circuit*;

(4) a single *generating unit* (or multiple *generating units* sharing a common circuit breaker or that would be disconnected via a single *outage*);

(5) a *reactive equipment*; or

(6) a section of *busbar*;

there must be no:

(7) *loss of demand* except as permitted by the Demand connection planning criteria detailed in clause 2.5.4;

(8) *unacceptable overloading* of any *transmission equipment*;

(9) *unacceptable voltage conditions*; or

(10) *system instability*.

2.5.4 Demand connection planning criteria

This section presents the planning criteria for the connection of *demand groups* to the *transmission system*. The provisions are intended to prescribe the required level of *power system security* and *transmission network adequacy* to be delivered by the *Network Service Provider*.

2.5.4.1 Demand connection capacity requirements

Note:
The *group demand* applicable for the assessment of demand connection capacity requirements is dependent on the nature of the associated connections.

(a) Where the *demand group* includes only demand, the *group demand* for future years is equal to the *Network Service Provider's* estimated demand for the group after considering demand diversity including during *planned outage* conditions and following *fault outages* affecting the *demand group*.

(b) Where the *demand group* includes both demand and *generation*, the *group demand* for future years is equal to:

(1) the *Network Service Provider's* estimated demand for the group after considering demand diversity and taking into account the expected operation of *non-market generation* within the *demand group* including during *planned outage* conditions and following *fault outages* affecting the *demand group;* plus

(2) the output of any *market generation* within the *demand group.*

2.5.4.2 Background conditions

(a) The *transmission capacity* for the connection of a *demand group* must meet the criteria set out in clauses 2.5.4.3, 2.5.4.4, 2.5.4.5 and 2.5.4.6 under the following background conditions:

(1) when there are no *planned outages*, the demand shall be set equal to *group demand*;

(2) when there is a *planned outage* affecting the *demand group*, the demand shall be set equal to *maintenance period demand*; and

(3) any *transfer capacity* identified by the *Network Service Provider* shall be represented taking account of any restrictions on the timescales in which the *transfer capacity* applies. Any *transfer capacity* identified by the *Network Service Provider* for use in *planning timescales* must be reflective of that which could practically be used in *operational timescales*.

(b) When planning an *outage* affecting a *demand group* >250 MVA the *Network Service Provider* may assume *generating units* can be rescheduled in accordance with the *WEM Rules* to mitigate the impact of any subsequent *unplanned outage* or *fault outage*.

2.5.4.3 Pre-fault criteria with *intact system*

(a) The *transmission capacity* for the connection of a *demand group* must be planned such that, for the background conditions described in clause 2.5.4.2, under *intact system* conditions there must be no:

(1) equipment loadings exceeding the *pre-fault rating*;

(2) *unacceptable voltage conditions*; or

(3) *system instability*.

2.5.4.4 Post-fault criteria with *intact system*

(a) The *transmission capacity* for the connection of a *demand group* shall be planned such that for the background conditions described in clause 2.5.4.2 and following the *credible contingency* of a *fault outage* of:

(1) a single *transmission circuit*;

(2) a single *zone substation transformer*;

(3) a single *generation circuit*;

(4) a single *generating unit* (or multiple *generating units* sharing a common circuit breaker or that would be disconnected via a single *outage*);

(5) a single *reactive equipment*; or

(6) a single section of *busbar*;

there must be no:

(7) *loss of demand* except as specified in Table 2-10;

(8) *unacceptable overloading* of any *transmission equipment*;

(9) *unacceptable voltage conditions*; or

(10) *system instability*.

2.5.4.5 Pre-fault criteria with *local system outage*

(a) The *transmission capacity* for the connection of a *demand group* shall also be planned such that for the background conditions described in clause 2.5.4.2 during the *planned outage* and prior to any *fault outage* occurring, there must be no:

(1) equipment loadings exceeding *pre-fault ratings*;

(2) *unacceptable voltage conditions*;

(3) *system instability*.

2.5.4.6 Post-fault criteria with *local system outage*

(a) The *transmission capacity* for the connection of a *demand group* shall also be planned such that for the background conditions described in clause 2.5.4.2 and the initial conditions of a *planned outage* of:

(1) a single *transmission circuit*;

(2) a single *zone substation transformer*;

(3) a single *generation circuit*;

(4) a single *generating unit* (or multiple *generating units* sharing a common circuit breaker or that would be disconnected via a single *outage*);

(5) a single *reactive equipment*;

(6) a single section of *busbar*; or

(7) a single circuit breaker,

for the *credible contingency* of a *fault outage* of:

(8) a single *transmission circuit*;

(9) a single *zone substation transformer*;

(10) a single *generation circuit*;

(11) a single *generating unit* (or multiple *generating units* sharing a common circuit breaker or that would be disconnected via a single *outage*);

(12) a *reactive equipment*; or

(13) a single section of *busbar*;

there must be no:

(14) *loss of demand* except as specified in Table 2-10;

(15) *unacceptable overloading* of any *transmission equipment*;

(16) *unacceptable voltage conditions*; or

(17) *system instability*.

Note:
For clarity, clauses 2.5.4.6(a)(14), 2.5.4.6(a)(16), and 2.5.4.6(a)(17) can be achieved through several means such as pre-fault switching to achieve network reconfiguration, use of automated systems or network reinforcement. Any systems which result in the disconnection of demand must ensure the limits set out in Table 2-10 are not exceeded.

Where non-network reinforcement solutions are adopted, these must be documented and appropriately implemented including investment in associated plant, equipment and control schemes as required.

(b) The *transmission capacity* for the connection of a *demand group* shall also be planned such that for the background conditions described in clause 2.5.4.2 and the initial conditions of:

(1) the single *unplanned outage* or *fault outage* of a *transmission circuit* or *zone substation transformer* for the *Perth CBD*

for the *credible contingency* of:

(2) a single *fault outage* of a *transmission circuit* or *zone substation transformer* for the *Perth CBD*

there must be no:

(3) *loss of demand* except as specified in Table 2-10;

(4) *unacceptable overloading* of any *transmission equipment*;

(5) *unacceptable voltage conditions*; or

(6) *system instability*.

Note:

For clarity, clauses 2.5.4.6(b)(3), 2.5.4.6(b)(5) and 2.5.4.6(b)(6) can be achieved through several means such as pre-fault switching to achieve network reconfiguration, use of automated systems or network reinforcement. Any systems which result in the disconnection of demand must ensure the limits set out in Table 2-10 are not exceeded.

Where non-network reinforcement solutions are adopted, these must be documented and appropriately implemented including investment in associated plant, equipment and control schemes as required.

2.5.4.7 Permitted demand loss following specified *credible contingencies*

(a) In planning the *transmission capacity* for the connection of a *demand group,* the permitted *loss of demand* and associated duration of that demand loss for considered *credible contingencies* are set out in Table 2-10.

(b) Following the coincident occurrence of two *unplanned outage*s or *fault outage*s affecting a *demand group* excluding the *Perth CBD* area*, group demand* can be lost for the duration of the associated repair time.

Note:

A demand connection is deemed adequate if the demand loss set out in the table is not exceeded for the specified *credible contingencies*.

The *power system security* requirements are set out in clauses 2.5.4.3, 2.5.4.4, 2.5.4.5 and 2.5.4.6 of these *Rules*. These requirements must also be met.

Table 2-10 Permitted *loss of demand* following specified *credible contingencies*

Area	***Loss of demand***	**Considered *credible contingency***	**With the initial conditions of:**		
			Intact system	**Planned *local system outage***	**Unplanned *local system outage*[3]**
			the permitted *loss of demand* for the next *credible contingency* is:		
Rural	<10 MVA	*zone substation transformer*	*group demand* for the repair time	*maintenance period demand* for the repair time	*group demand* for the repair time
	≥10 MVA & <60 MVA	*zone substation transformer*	*group demand* for the remote *switching time*	*maintenance period demand* for the *emergency return to service* time	*group demand* for the repair time
	<20 MVA	*transmission circuit*	*group demand* for the repair time	*maintenance period demand* for the repair time	*group demand* for the repair time
	≥20 MVA & <90 MVA	*transmission circuit*, *generator circuit* or *reactive equipment*	None[1]	*maintenance period demand* for the *emergency return to service* time	*group demand* for the repair time
	≥90 MVA & <250 MVA	*transmission circuit*, *generator circuit*, *reactive equipment* or *busbar*	None	*maintenance period demand* for the *emergency return to service* time	*group demand* for the repair time
Urban	<60 MVA	*zone substation transformer*	*group demand* for the remote *switching time*	*maintenance period demand* for the *emergency return to service* time	*group demand* for the repair time
	<90 MVA	*transmission circuit*, *generator circuit* or *reactive equipment*	None	*maintenance period demand* for the *emergency return to service* time	*group demand* for the repair time
	≥90 MVA & <250 MVA	*transmission circuit*, *generator circuit*, *reactive equipment* or *busbar*	None	*maintenance period demand* for the *emergency return to service* time	*group demand* for the repair time
Perth CBD	<60 MVA	*zone substation transformer*	*group demand* for 30 seconds	*maintenance period demand* for 2 hours	*group demand* for 2 hours[3]
	<90 MVA	*transmission circuit*, *generator circuit* or *reactive equipment*	None[2]	*maintenance period demand* for 2 hours	*group demand* for 2 hours[3]
	≥90 MVA & <250 MVA	*transmission circuit*, *generator circuit*, *reactive equipment* or *busbar*	None[2]	*maintenance period demand* for 2 hours	*group demand* for 2 hours[3]
All areas	≥250 MVA	*transmission circuit*, *generator circuit*, *reactive equipment* or *busbar*	None	None	*group demand* for the repair time

Notes:

(1) < *Remote switching time* may be permitted for up to 60 MVA subject to economic justification consistent with guidance in Attachment 13.

(2) <60 MVA *group demand* can be lost for <30 seconds if contingency involves *zone substation transformer*

(3) For the *Perth CBD* area, the initial conditions are an unplanned *local system outage* or a *fault outage*.

2.5.5 *Main Interconnected Transmission System* and *sub transmission system* planning criteria

This section describes the planning criteria for the *Main Interconnected Transmission system (MITS)* and *sub transmission system*.

2.5.5.1 Background conditions

(a) The background conditions for planning the *MITS* and *sub transmission system* are described in the guideline (the Transmission Planning Guideline) developed by the *Network Service Provider* in accordance with clause 2.5.2(j) of these *Rules*.

(b) The *transmission capacity* of the *MITS* and *sub transmission system* shall be planned to withstand the coincident *planned* and *fault outages* of the *transmission elements* specified in clause 2.5.5.5 at *group demand* up to, but not exceeding, the applicable *maintenance period demand*.

2.5.5.2 Pre-fault criteria with *intact system*

(a) The *transmission capacity* of the *MITS* and *sub transmission system* shall be planned such that, for the background conditions specified in clause 2.5.5.1, prior to any *fault outage* there must be no:

(1) equipment loadings exceeding the *pre-fault rating*;

(2) *unacceptable voltage conditions*; or

(3) *system instability*.

2.5.5.3 Post-fault criteria with *intact system*

(a) The *transmission capacity* of the *MITS* and *sub transmission system* shall also be planned such that for the background conditions described in clause 2.5.5.1 and for the *credible contingency* of a *fault outage* of any of the following:

(1) a single *transmission circuit;*

(2) a single *reactive equipment*;

(3) a single *generation circuit;*

(4) a single *generating unit* (or multiple *generating units* sharing a common circuit breaker or that would be disconnected via a single *outage*);

(5) a single section of *busbar*,

there must be no:

(6) *loss of demand* capacity except as permitted by the Demand connection planning criteria detailed in clause 2.5.4;

(7) *unacceptable overloading* of any *transmission equipment*;

(8) *unacceptable voltage conditions*; or

(9) *system instability*.

(b) The *transmission capacity* of the *MITS* shall be planned such that if there is a single *circuit breaker failure* resulting from a single phase to earth fault provided the system demand is less than 80% of expected *transmission system peak load* there must be no:

(1) *unacceptable overloading* of any *transmission equipment*;

(2) *unacceptable voltage conditions*; or

(3) *system instability.*

2.5.5.4 Pre-fault criteria with *local system outage*

(a) During the *planned outage* and prior to any *fault outage* occurring, there must be no:

(1) equipment loadings exceeding the *pre-fault rating*;

(2) *unacceptable voltage conditions*; or

(3) *system instability*.

2.5.5.5 Post-fault criteria with *local system outage*

(a) The *transmission capacity* of the *MITS* and *sub transmission system* shall be planned such that for the background conditions described in clause 2.5.5.1 with the initial conditions of a *planned outage* of:

(1) a single *transmission circuit*;

(2) a single *reactive equipment*;

(3) a single *generation circuit*;

(4) a single circuit breaker;

(5) a single *generating unit* (or multiple *generating units* sharing a common circuit breaker or that would be disconnected via a single *outage*); or

(6) a single section of *busbar*.

for the *credible contingency* of a *fault outage* of:

(7) a single *transmission circuit*;

(8) a single *reactive equipment*;

(9) a single *generation circuit;*

(10) a single *generating unit* (or multiple *generating units* sharing a common circuit breaker or that would be disconnected via a single *outage*); or

(11) a single section of *busbar*;

there must be no:

(12) *loss of demand* except as permitted by the Demand connection planning criteria detailed in section 2.5.4);

(13) *unacceptable overloading* of any *transmission equipment*;

(14) *unacceptable voltage conditions*; or

(15) *system instability*.

Note:

For clarity, clauses 2.5.5.5(a)(13), 2.5.5.5(a)(14) and 2.5.5.5(a)(15) can be achieved through several means such as pre-fault switching to achieve network reconfiguration, use of automated systems or network reinforcement. Any systems which automatically *disconnect* demand to comply with the requirements of 2.5.5.3 and 2.5.5.5 must ensure the limits set out in Table 2-10 are not exceeded.

Where non-network reinforcement solutions are adopted, these must be documented and appropriately implemented including investment in associated plant, equipment and control schemes as required.

(b) In determining whether the requirements described above have been met, the *Network Service Provider* may assume that, during the *planned outage*, *generation* has been rescheduled in accordance with the *WEM Rules* to the extent possible to mitigate the effect of a subsequent *fault outage*.

2.5.5.6 Other *MITS* and *sub transmission system* requirements

(a) Under the System Security Background conditions (set out in the guideline (the Transmission Planning Guideline) developed by the *Network Service Provider* in accordance with clause 2.5.2(j) of these *Rules*), the criteria in clauses 2.5.5.2 to 2.5.5.5 must be met.

(b) Under the System Economy Background conditions (set out in the guideline (the Transmission Planning Guideline) developed by the *Network Service Provider* in accordance with clause 2.5.2(j) of these *Rules*), the criteria in clauses 2.5.5.2 to 2.5.5.5 must be met when there is sufficient economic justification.

(c) When considering investment in accordance with clauses 2.5.5.6(a) and 2.5.5.6(b) the *Network Service Provider* should consider network and non-network solutions except where operational measures, including *constraints*, suffice to meet the criteria.

(d) Where operational measures, including *constraints,* are used in accordance with clause 2.5.5.6(c):

(1) maintenance *access* for each *transmission circuit* must be able to be achieved; and

(2) the operational measures must be economically justified by the *Network Service Provider*.

(e) For potential *MITS* and *sub transmission system augmentations* identified following assessment using the System Economy Background conditions (set out in the guideline (the Transmission Planning Guideline) developed by the *Network Service Provider* in accordance with clause 2.5.2(j) of these *Rules*), the *Network Service Provider* must use data and assumptions in the economic justification that align with those used in the Whole of System Plan published in accordance with section 4.5A of the *WEM Rules.*

2.5.6 Fault limits

The calculated maximum fault level at any point in the *transmission system* must not exceed 95% of the equipment fault rating at that point.

2.5.7 *Maximum fault currents*

The *maximum fault current* at the *connection point* of a *User connected* to the *transmission system* shall be as specified in the relevant *connection agreement*.

2.6 DISTRIBUTION SYSTEM PLANNING CRITERIA

2.6.1 Application

Section 2.6 sets out the *distribution system* planning criteria*.* The *Network Service Provider* must design the *distribution system* in accordance with the applicable *distribution system* planning criteria described below.

2.6.2 *High voltage distribution system*

2.6.2.1 Application of the *N-0 criterion*

(a) The *Network Service Provider* may, unless *good electricity industry practice* dictates otherwise, design and operate the *distribution system* to the N-0 criterion.

(b) The *Network Service Provider* may negotiate an enhanced security of *supply* with *Users* requiring a high level of *supply* reliability. Details of the agreed enhanced level of security of *supply* must be included in the *connection agreement*. The *Network Service Provider* is under no obligation to provide a *User* with an enhanced level of security and *Users* should note that provision of an enhanced level of security through connection to the *transmission or distribution system* is often neither economic nor practical. Hence, *Users* requiring an enhanced level of security of *supply* may need to make alternative arrangements such as the provision of on-site standby *generation*.

2.6.2.2 *Distribution* feeders in the *Perth CBD*

Distribution feeders in the *Perth CBD* and those *connected* to *zone substations* within the *Perth CBD* must be designed so that in the event of an unplanned loss of *supply* due to the failure of equipment on a *high voltage distribution system*, the *Network Service Provider* can use remotely controlled switching to restore *supply* to those sections of the *distribution feeder* not directly affected by the fault.

2.6.2.3 Urban *distribution feeders*

(a) Existing urban *distribution* feeders

Urban *distribution feeders* in existence at the *Rules commencement date* must be designed so that, in the event of an unplanned single feeder *outage* due to an equipment failure within the *zone substation* or a failure of the exit cable, the *load* of that feeder can be transferred to other *distribution feeders* by manual reconfiguration.

> **Note:**
> For existing feeders, due to historical *substation* and feeder loading practices, this design requirement may not currently be achieved at 100% *peak load*. In this event some *load shedding* may be necessary at times of high *load* after reconfiguration of the *distribution system* following the *outage* of a single *distribution feeder*. However, in the long term, future network reinforcements will allow for 100% of *peak load* to be transferred, thereby avoiding the need for such *load shedding*.

(b) Urban *distribution feeders* constructed after the *Rules commencement date*

(1) Where practical, any new urban *distribution feeder* must be split into two radial spurs at the end of the *zone substation* exit cable; and

(2) the *distribution feeder* must be designed so that, if an unplanned single feeder *outage* occurs due to an equipment failure within the *zone substation* or a failure of the exit cable, the *load* on the faulted feeder can be transferred to other feeders in accordance with the following provisions:

(A) no other *distribution feeder* will pick up more than 50% of the *peak load* from the faulted *distribution feeder* unless capacity has been specifically reserved to provide back-up;

(B) the *distribution feeder(s)* picking up the *load* can be from another *zone substation*; and

(C) any new underground *distribution feeder* or portion of a new underground *distribution feeder* that has an installed *transformer* capacity of 1 MVA or more must be designed so that, as soon as adjacent developments permit, an alternative source of *supply* that is normally open can be closed to provide *supply,* if a fault occurs on the normal *supply*.

2.6.2.4 Radial *distribution feeder loads* in the Perth metropolitan area

For all *distribution feeders* within the Perth metropolitan area, the *Network Service Provider* must limit the number of residential *Users* who consumes electricity supplied through a *connection point* in a *switchable feeder section* to 860, if the *switchable feeder section* is not able to be energised through a back-up normally open interconnection.

2.6.2.5 Rural *distribution* feeders

Where technically and economically feasible, the *Network Service Provider* must provide normally open interconnections between adjacent rural *distribution feeders*.

2.6.3 *Low voltage distribution system*

2.6.3.1 General

(a) The *Network Service Provider* may design the radial *low voltage distribution systems* to the N-0 criterion. However, where technically and commercially feasible, interconnection between *low voltage* feeders may be provided.

(b) For underground residential subdivisions, the *Network Service Provider* must ensure that all *low voltage* circuits have a switching point for every 16 *connection points*.

2.6.3.2 Pole to pillar *connection points* mandatory

All new *low voltage connection points* and service mains, and upgrades to existing overhead service mains due to capacity increases, must be underground, even if the service mains are to be *connected* to an overhead *distribution* line.

2.6.4 Fault limits

The calculated maximum fault level at any point in the *distribution system* must not exceed 95% of the equipment fault rating at that point.

2.6.5 *Maximum fault currents*

(a) The *Network Service Provider* must design and construct the *distribution system* so that the potential *maximum fault currents* do not exceed the following values:

(1) 415 V networks 31.5 kA where supplied from one *transformer*; or

(2) 63 kA where supplied from two *transformers* in parallel, except where a higher *maximum fault current* is specified in a *User's connection agreement*.

(3) 6.6 kV networks 21.9 kA

(4) 11 kV networks 25 kA

(5) 22 kV networks 16 kA

(6) 33 kV networks 13.1 kA

(b) Equipment may be installed with a lower fault *current rating* in accordance with applicable requirements of the *Electricity (Network Safety) Regulations 2015* where the fault level is unlikely to exceed the lower rating for a *credible contingency.*

2.6.6 *Distribution* design criteria

(a) All *distribution systems* must be designed to *supply* the *maximum reasonably foreseeable load* anticipated for the area served.

(b) *Distribution systems* must be designed to minimise the cost of providing additional *distribution system* capacity should electricity consumption patterns change.

(c) *High voltage* switchgear and *distribution transformers* should be located close to the centre of the *loads* to be supplied.

(d) The *Network Service Provider* may remotely monitor and/or control *high voltage* switchgear where this can be shown to be the most cost efficient approach, including where this assists meeting the reliability targets set out in the *access arrangement.*

(e) *High voltage* switchgear that is not remotely monitored must be fitted with local fault passage indication.

(f) Ground mounted *distribution transformers* rated above 300 kVA must provide:

(1) local indication of actual and *peak load*;

(2) remote monitoring of (signed) *active power* (kW) and *reactive power* (kvar), *voltage* and current. Additional parameters may be provided for the purpose of maintaining compliance of the *distribution system* with these *Rules.*

> **Note:**
> Clause 2.6.6(f)(2) may be achieved through the use of the equipment that allows for remote monitoring on the *distribution transformer* or alternative equipment installed elsewhere in the network that achieves the same level of remote monitoring for required parameters.

(g) The *Network Service Provider* may install equipment that enables remote monitoring on existing *distribution transformers* for the purpose of maintaining compliance of the *distribution system* with these *Rules.*

> **Note:**
> Examples where clause 2.6.6(g) may be applied include improving network hosting capacity for distributed energy resources or electric vehicles, dynamic network management (including bi-directional flow) or addressing volatility in *User* behaviour.

2.7 TRANSMISSION AND DISTRIBUTION SYSTEM DESIGN AND CONSTRUCTION STANDARDS

When designing and constructing the *transmission and distribution systems,* the *Network Service Provider* must comply with these *Rules*, the *Access Code* and the Electricity (Network Safety) Regulations 2015.

To the extent reasonable and practicable, the *Network Service Provider* should follow any relevant *Australian Standards,* International Electricity Commission (IEC) Standards and Electricity Networks Association Guides.

2.8 DISTRIBUTION CONDUCTOR OR CABLE SELECTION

Extensions and reinforcements to the *distribution system* must be designed and constructed in accordance with a *distribution system* concept plan for the area. The installation must conform to the concept plan and use conductors or cables that are:

(a) configured with the objective of minimising the lifetime cost to the community; and

(b) of a standard carrier size that is equal to or greater than that required for the reasonably foreseeable *load*.

2.9 TRANSMISSION AND DISTRIBUTION SYSTEM PROTECTION

2.9.1 General requirements

(a) All *primary equipment* on the *transmission and distribution system* must be protected so that if an equipment fault occurs, the faulted equipment item is automatically removed from service by the operation of circuit breakers or fuses. *Protection systems* must be designed and their settings coordinated so that, if there is a fault, unnecessary equipment damage is avoided and any reduction in *power transfer capability* or in the level of service provided to *Users* is minimised.

(b) Consistent with the requirement of clause 2.9.1(a), *protection systems* must remove faulted equipment from service in a timely manner and ensure that, where practical, those parts of the *transmission and distribution system* not directly affected by a fault remain in service.

(c) *Protection systems* must be designed, installed and maintained in accordance with *good electricity industry practice*. In particular, the *Network Service Provider* must ensure that all new *protection apparatus* complies with IEC Standard 60255 and that all new *current transformers* and *voltage transformers* comply with IEC Standard 61869.

2.9.2 Duplication of *protection*

(a) *Transmission system*

(1) *Primary equipment* operating at *transmission system voltages* must be protected by a *main protection system* that must remove from service only those items of *primary equipment* directly affected by a fault. The *main protection system* must comprise *two fully independent protection schemes*. One of the independent *protection schemes* must include earth fault *protection*.

(2) *Primary equipment* operating at *transmission system voltages* must also be protected by a *back-up protection system* in addition to the *main protection system*. The *back-up protection system* must isolate the faulted *primary equipment* if a *small zone fault* occurs, or a *circuit breaker failure* condition occurs. For *primary equipment* operating at nominal *voltages* of 220 kV and above the *back-up protection system* must comprise *two fully independent protection schemes* that must discriminate with other *protection schemes*. For *primary equipment* operating at nominal *voltages* of less than 220 kV the *back-up protection system* must incorporate at least one *protection scheme* to protect against *small zone faults* or a *circuit breaker failure*. For *protection* against *small zone faults* there must also be a second *protection scheme* and, where this is co-located with the first *protection scheme*, together they must comprise *two fully independent protection schemes*.

(3) The design of the *main protection system* must make it possible to test and maintain either *protection scheme* without interfering with the other.

(4) *Primary equipment* operating at a *high voltage* that is below a *transmission system voltage* must be protected by *two fully independent protection systems* in accordance with the requirements of clause 2.9.2(b)(1).

(b) *Distribution system*

(1) Other than *primary equipment* forming part of the *distribution system* and normally protected by fuses, each item of *primary equipment* forming part of the *distribution system* must be protected by two independent *protection systems*. One of the independent *protection systems* must be a *main protection system* that must remove from service only the faulted item of *primary equipment.* The other independent *protection system* may be a *back-up protection system*.

(2) Notwithstanding the requirements of clause 2.9.2(b)(1), where a part of the *distribution system* may potentially form a separate island the *protection system* that provides *protection* against islanding must comprise *two fully independent protection schemes* and comply with the requirements of clause 2.9.2(a)(3).

2.9.3 Availability of *protection systems*

(a) Subject to clauses 2.9.3(b) and 2.9.3(c), all *protection schemes*, including any back-up or *circuit breaker failure protection scheme*, forming part of a *protection system* protecting part of the *transmission or distribution system* must be kept operational at all times, except that one *protection scheme* forming part of a *protection system* can be taken out of service for period of up to 48 hours.

(b) Should a *protection scheme* forming part of the *main* or *back-up protection system* protecting a part of the *transmission system* be out of service for longer than 48 hours, the *Network Service Provider* must remove the protected part of the *transmission system* from service, except:

(1) when instructed otherwise by *AEMO;* or

(2) if undertaking a *planned outage* of a *protection scheme*, after conducting a formal risk assessment and putting in place an acceptable risk mitigation plan approved by *AEMO.*

(c) Should either of the two *protection schemes* protecting a part of the *distribution system* be out of service for longer than 48 hours, the *Network Service Provider* must remove the protected part of the *distribution system* from service, except:

(1) when the part of the *distribution system* must remain in service to maintain *power system stability*; or

(2) after conducting a formal risk assessment and putting in place an acceptable risk mitigation plan.

2.9.4 Maximum total *fault clearance times*

(a) This clause 2.9.4 applies to zero impedance short circuit faults of any type on *primary equipment* at nominal system *voltage.* Where *critical fault clearance times* exist, these times may be lower and take precedence over the times stated in this clause 2.9.4*. Critical fault clearance time* requirements are set out in clause 2.9.5.

(b) For *primary equipment* operating at *transmission system voltages* the maximum *total fault clearance times* in Table 2-11 and Table 2-12 apply to the nominal *voltage* of the circuit breaker that clears a particular fault contribution for both *minimum system conditions* and *maximum system conditions*. For *primary equipment* operating at *distribution system voltages* the maximum *total fault clearance times* specified for 33 kV and below may be applied to all circuit breakers required to clear a fault for *maximum system conditions*, irrespective of the nominal *voltage* of a circuit breaker.

(c) For *primary equipment* operating at a nominal *voltage* of 220 kV and above:

(1) operation of either *protection scheme* of the *main protection system* must achieve a *total fault clearance time* no greater than the "No CB Fail" time given in Table 2-11; and

(2) operation of either *protection scheme* of the *back-up protection system* must achieve a *total fault clearance time* no greater than the "CB Fail" time given in Table 2-11.

(d) For *primary equipment* operating at 132 kV and 66 kV:

(1) one of the *protection schemes* of the *main protection system* must operate to achieve a *total fault clearance time* no greater than the "No CB Fail" time given in Table 2-11. The other *protection scheme* of the *main protection system* must operate to achieve a *total fault clearance time* no greater than the "No CB Fail" time in Table 2-12. The *back-up protection system* must achieve a *total fault clearance time* no greater than the "CB Fail" time in Table 2-11, except that the second *protection scheme* that protects against *small zone faults* must achieve a *total fault clearance time* no greater than 400 msec;

(2) on 132 kV lines longer than 40 km, all *main* and *back-up protection schemes* must operate to achieve the relevant maximum *total fault clearance time* given in Table 2-12; and

(3) on 66 kV lines longer than 40 km, one *protection scheme* of the *main protection system* must operate to achieve the *total fault clearance times* specified for 132 kV in Table 2-12 (rather than the times specified in Table 2-11). The other *protection scheme* of the *main protection system* must operate to achieve the maximum *total fault clearance times* specified for 66 kV in Table 2-12.

(e) For a *small zone fault* coupled with a *circuit breaker failure*, maximum *total fault clearance times* are not defined.

(f) In Table 2-11 and Table 2-12, for *voltages* of 66 kV and above, the term "local end" refers to the circuit breaker(s) of a *protection system* where the fault is located:

(1) within the same *substation* as the circuit breaker;

(2) for a *transmission line* between two *substations*, at or within 50% of the line impedance nearest to the *substation* containing the circuit breaker, provided that the line is terminated at that *substation*;

(3) for a *transmission line* between more than two *substations*, on the same line section as the *substation* containing the circuit breaker, provided that the line is terminated at that *substation*.

(g) In Table 2-11 and Table 2-12, for *voltages* of 66 kV and above, the term "remote end" refers to all circuit breakers required to clear a fault, apart from those specified in clause 2.9.4(f).

> **Note:**
> Where one or more circuit breakers required to clear a fault are located in a different *substation* from that at which a line is terminated, situations may arise where all circuit breakers required to clear a fault may operate within the remote end *total fault clearance time*.

(h) In Table 2-11, for *primary equipment* operating at nominal *voltages* of 33 kV and below, the term “local end” refers only to faults located within the *substation* in which a circuit breaker is located.

(i) The term "existing equipment" refers to equipment in service at the *Rules commencement date*.

(j) Notwithstanding the requirements of clause 2.9.4, where *weak infeed fault conditions* result from the connection of a *generating system*:

(1) where the risk of undetected islanding of a part of the *transmission or distribution system* and a *Generator’s facility* is deemed **significant** by the *Network Service Provider*, the following applies:

(A) the *total fault clearance time* of one of the *protection schemes* shall meet the remote end *total fault clearance time* of Table 2-12; and

(B) the *total fault clearance time* of the other *protection scheme* shall be as deemed necessary by the *Network Service Provider* to prevent damage to the *transmission or distribution system* and to meet *power system stability* requirements;

(2) where the risk of undetected islanding of a part of the *transmission or distribution system* and a *Generator’s facility* is deemed **not significant** by the *Network Service Provider,* the following applies:

(A) the *total fault clearance time* of the two *protection schemes* shall be as deemed necessary by the *Network Service Provider* to prevent damage to the *transmission or distribution system* and to meet *power system stability* requirements.

(k) Notwithstanding the requirements of clause 2.9.4, where *weak infeed conditions* result from the connection of *generating system* coupled with a *circuit breaker failure*, *maximum total fault clearance times* are not defined.

> **Note:**
> The assessment for *weak infeed fault conditions* resulting from the connection of *generating units* shall not go beyond the *transmission line* remote end isolator, which is deemed the accepted practicable point of assessment.
> In determining the requirements for clause 2.9.4(j) and 2.9.4(k), the *Network Service Provider* should consider the requirements for *Generator* protection as defined in section 3.5 of these *Rules*.

Table 2-11 Maximum *total fault clearance times* (msec)

		Existing equipment no CB fail	Existing equipment CB fail	New equipment no CB fail	New equipment CB fail
220 kV and above	Local end	120	370	100	270
	Remote end	180	420	140	315
66 kV and 132 kV	Local end	150	400	115	310
	Remote end	200	450	160	355
33 kV and below	Local end	1160	1500	1160	1500
	Remote end	Not defined	Not defined	Not defined	Not defined

Table 2-12 Alternative maximum *total fault clearance times* (msec) for 132 kV and 66 kV lines

		Existing equipment no CB fail	Existing equipment CB fail	New equipment no CB fail	New equipment CB fail
132 kV	Local end	150	400	115	310
	Remote end	400	650	400	565
66 kV	Local end	1000	Not defined	115	310
	Remote end	Not defined	Not defined	400	565

2.9.5 *Critical fault clearance times*

(a) Notwithstanding the requirements of clause 2.9.4, where necessary to ensure that the *power system* complies with the performance standards specified in clause 2.2*,* the *Network Service Provider* may designate a part of the *transmission or distribution system* as subject to a *critical fault clearance time*. The *critical fault clearance time* may be lower than the standard maximum *total fault clearance time* set out in Table 2-11. The network configurations to which the *critical fault clearance time* applies shall be specified by the *Network Service Provider*.

(b) All *primary equipment* that is subject to a *critical fault clearance time* must be protected by a *main protection system* that meets all relevant requirements of clause 2.9.2. Both *protection schemes* of the *main protection system* must operate within a time no greater than the *critical fault clearance time* specified by the *Network Service Provider*.

2.9.6 *Protection sensitivity*

(a) *Protection schemes* must be sufficiently sensitive to detect fault currents in the *primary equipment* taking into account the errors in *protection apparatus* and *primary equipment* parameters under the system conditions in this clause 2.9.6.

(b) For *minimum system conditions* and *maximum system conditions,* all *protection schemes* must detect and discriminate for all *primary equipment* faults within their intended normal operating zones.

(c) For *abnormal equipment conditions* involving two *primary equipment outages*, all *primary equipment* faults must be detected by one *protection* scheme and cleared by a *protection system*. Back-up *protection systems* may be relied on for this purpose. *Fault clearance times* are not defined under these conditions.

2.9.7 Trip *supply* supervision requirements

(a) Where loss of power *supply* to its secondary circuits would result in *protection scheme* performance being reduced, all *protection scheme* secondary circuits must have *trip supply supervision*.

2.9.8 *Trip circuit supervision* requirements

(a) All *protection scheme* secondary circuits that include a circuit breaker trip coil have *trip circuit supervision*, which must monitor the trip coil when the circuit breaker is in both the open and closed position and alarm for an unhealthy condition.

2.9.9 *Protection* flagging and indication

(a) All protective devices supplied to satisfy the *protection* requirements must contain such indicating, flagging and event recording that is sufficient to enable the determination, after the fact, of which devices caused a particular trip.

(b) Any failure of the tripping supplies, *protection apparatus* and circuit breaker trip coils must be alarmed and the *Network Service Provider* must put in place operating procedures to enable prompt action to be taken to remedy such failures.

3. *TECHNICAL REQUIREMENTS OF USER FACILITIES*

3.1 INTRODUCTION

(a) This Chapter 3 sets out details of the technical requirements that *Users* must satisfy as a condition of *connection* of any equipment to the *transmission and distribution systems* (including *loads*, *generating systems* and *electricity storage facilities*), except where granted an exemption by the *Network Service Provider* in accordance with sections 12.33 to 12.39 or the *Authority* in accordance with sections 12.40 to 12.49 of the *Access Code*.

(b) This Chapter 3 assumes the times a *User's facility* may operate will not be restricted, except in accordance with these *Rules* and other relevant laws. Additional operating restrictions may be agreed by a *Network Services Provider* and a *User.* In such circumstances, the *Network Services Provider* may impose requirements over and above those shown in this Chapter 3 to ensure that the *User's facility* only operates in accordance with the agreed restrictions. The additional operating restrictions and any additional requirements must be specified in the relevant *connection agreement* or *User operating protocol*.

(c) The objective of this Chapter 3 is to facilitate maintenance of the *power system* performance standards specified in section 2.2, so that other *Users* are not adversely affected and that personnel and equipment safety are not put at risk following, or as a result of, the *connection* of a *User's* equipment.

> **Note:**
> The scope of these *Rules* does not include the technical requirements for the provision of services either in accordance with the relevant provisions of the *WEM Rules* or under a commercial arrangement with the *Network Services Provider*. *Users* who provide those services may be required to comply with technical requirements over and above those specified in this Chapter 3. These additional requirements will be specified in the relevant services contract.

(d) All *Users,* including *transmission connected market generators,* must comply with the requirements specified in section 3.2. Additional requirements specified in sections 3.3 to 3.8 may apply depending on the type of equipment within the *User's facility*, the equipment*'s* rated capacity and connection arrangement.

(1) Table 3-1 lists the sections that specify the technical requirements for *transmission connected User facilities*.

(2) Table 3-2 lists the sections that specify the technical requirements for *distribution connected User facilities*.

> **Note:**
> *Transmission connected market Generators* may have *generator performance standards* developed through the process defined in the *WEM Rules.* These *Generator*s do not need to negotiate *generator performance standards* through the process outlined in these *Rules* if they have agreed *generator performance standards* via the *WEM Rule* process. However, they must comply with all other technical requirements in these *Rules*.

Table 3-1 Technical requirements for *User facilities connected* to the *transmission system*

Equipment	Operating mode	Rated capacity (1)	Applicable sections of these *Rules*
load	-	All	sections 3.1, 3.2, 3.4 and 3.5
electricity storage	consuming *active power* (i.e., charging)		
electricity storage	discharging *active power*	> 5 MVA	sections 3.1, 3.2, 3.3 and 3.5
		≤ 5 MVA	sections 3.1, 3.2, 3.5 and 3.6
generating system	-	> 5 MVA	sections 3.1, 3.2, 3.3 and 3.5
		≤ 5 MVA	sections 3.1, 3.2, 3.5 and 3.6

(1) For *generating systems* or *electricity storage* the rated capacity is the total capacity of all *generating units* or storage devices that generate or discharge *apparent power* in parallel with the *power system* at a common *connection point*. For *load* or *electricity storage* consuming *active power,* the rated capacity is the total capacity of all *load* or storage devices that consume *apparent power* in parallel with the *power system* at a common *connection point*.

Table 3-2 Technical requirements for *User facilities connected* to the *distribution system*

Equipment	Operating mode	Rated capacity	Applicable sections of these *Rules*
load	-	All	sections 3.1, 3.2, 3.4 and 3.5
electricity storage	consuming *active power* (i.e., charging)		
generating system	-	> 5 MVA, *HV connected*	sections 3.1, 3.2, 3.3, and 3.5
electricity storage	discharging *active power*		
generating system	-	≤ 5 MVA, *HV connected*	sections 3.1, 3.2, 3.5, and 3.6
electricity storage	discharging *active power*		
generating system	-	*LV connected*, non-*standard connection service*	sections 3.1, 3.2, 3.5 and 3.7
electricity storage	discharging *active power*		
generating system	-	*LV connected*, *standard connection service*	sections 3.1, 3.2, 3.5 and 3.8
electricity storage	discharging *active power*		

(e) The mode of operation of a *generating unit* may be characterised as one of the following modes:

(1) being in continuous parallel operation with the *transmission or distribution system*, and either exporting electricity to the *transmission or distribution system* or not exporting electricity to it;

(2) being in occasional parallel operation with the *transmission or distribution system*, and either exporting electricity to the *transmission or distribution system* or not exporting electricity to it, including *generating units* participating in peak lopping and system *peak load* management for up to 200 hours per year;

(3) being in short term test parallel operation with the *transmission or distribution system*, and either exporting electricity to the *transmission or distribution system* or not exporting electricity to it, and having a maximum duration of parallel operation 2 hours per event and 24 hours per year; or

(4) bumpless (make before break) transfer operation, being:

(A) operation in rapid transfer mode where, when *load* is transferred between the *generating unit* and the *transmission or distribution system* or vice versa, the *generating unit* is synchronised for a maximum of one second per event; or

(B) operation in gradual transfer mode where, when *load* is transferred between the *generating unit* and the *transmission or distribution system* or vice versa, the *generating unit* is synchronised for a maximum of 60 seconds per event.

3.2 REQUIREMENTS FOR ALL USERS

3.2.1 *Power system* performance standards

(a) A *User* must ensure that each of its *facilities connected* to the *transmission or distribution system* is capable of operation while the *power system* is operating within the parameters of the *power system* performance standards set out in clause 2.2.

> **Note:**
> The overvoltage envelope specified in Figure 2-2, Figure 2-3 and Figure 2-4 provides for the level of transient overvoltage excursions expected on the periphery of the *transmission and distribution system*. *Users* proposing to connect equipment that is intolerant of high *connection point voltage* may request the *Network Service Provider* to undertake a study to determine the maximum potential overvoltage at the proposed *connection point*. The cost of such a study will be the responsibility of the *User* requesting it.

(b) Flicker

A *User* must maintain its contributions to flicker at the *connection point* below the limits allocated by the *Network Service Provider* under clause 2.3.1.

(c) Harmonics

(1) A *User* must comply with any harmonic emission limits allocated by the *Network Service Provider* in accordance with clause 2.3.2(a).

(2) Where no harmonic injection limit has been allocated in accordance with clause 2.3.2(a), a *User* must ensure that the injection of harmonics or interharmonics from its equipment or *facilities* into the *transmission or distribution systems* does not cause the maximum system harmonic *voltage* levels set out in Table 2-6 and Table 2-7 to be exceeded at the *connection point*.

(d) Negative Phase Sequence *Voltage*

(1) A *User connected* to all three phases must balance the current drawn in each phase at its *connection point* so as to achieve 10-minute average levels of negative sequence *voltage* at the *connection point* that are equal to or less than the values set out in Table 2-8.

(2) A *User* directly *connected* to the *transmission system* must be *connected* to all three phases.

(e) Electromagnetic Interference

A *User* must ensure that the electromagnetic interference caused by its equipment does not exceed the limits set out in Tables 1 and 2 of AS 2344 (2016).

(f) Fault Levels

(1) A *User connected* to the *transmission system* shall not install or connect equipment at the *connection point* that is rated for a *maximum fault current* lower than that specified in the *connection agreement* in accordance with clause 2.5.7.

(2) A *User connected* to the *distribution system*, who is not a *small use customer*, must not install equipment at the *connection point* that is rated for a *maximum fault current* lower than that specified in clause 2.6.5(a) unless a lower *maximum fault current* is agreed with the *Network Service Provider* and specified in the *connection agreement.*

(3) *Small use customers connected* to the *distribution system* may install equipment with a lower fault rating than the *maximum fault current* specified in clause 2.6.5(a)(1) in accordance with the applicable requirements of the *WA Electrical Requirements*.

Note:
Where a *User's* equipment increases the fault levels in the *transmission system*, responsibility for the cost of any upgrades to the equipment required as a result of the changed *power system* conditions will be dealt with by commercial arrangements between the *Network Service Provider* and the *User*.

(4) A *Generator* must ensure that the *maximum fault current* contribution from a *generating unit* or *small generating system* is not of a magnitude that will allow the total fault current at the *connection point* to exceed the levels specified in clause 2.5.7 for all *transmission system* operating conditions or 2.6.5(a) for all *distribution system* operating conditions.

(5) If the *connection* or *disconnection* of a *User's generating system* causes or is likely to cause excessively high or low fault levels, this must be addressed by measures agreed with the *Network Service Provider* and recorded in the relevant *connection agreement*.

3.2.2 Main switch

(a) Except as provided in clause 3.3.15, a *User* must be able to de-energise its own equipment without reliance on the *Network Service Provider*.

(b) A *User connected* to the *low voltage distribution system* must comply with AS/NZS 3000 with respect to the provision and location of main switch(s).

3.2.3 *User's* power quality *monitoring equipment*

(a) The *Network Service Provider* may require a *User* to provide accommodation and connections for the *Network Service Provider's* power quality monitoring and recording equipment within the *User's facilities* or at the *connection point*.

(b) The *User* must meet the requirements of the *Network Service Provider* in respect of the installation of the power quality monitoring and recording equipment and provide access for reading, operating and maintaining this equipment.

(c) The key inputs that the *Network Service Provider* may require a *User* to provide to the *Network Service Provider's* power quality monitoring and recording equipment include:

(1) three phase *voltage* and three phase current and, where applicable, neutral *voltage* and current; and

(2) digital inputs for circuit breaker status and *protection* operate alarms hardwired directly from the appropriate devices. If direct hardwiring is not possible and if the *Network Service Provider* agrees, then the *User* may provide inputs measurable to 1 millisecond resolution and GPS synchronised.

3.2.4 Modelling data for *power system* simulation studies

(a) A *User* must provide to the *Network Service Provider* modelling information for their *facilities* as specified in the 'Generator and Load Model Guidelines' produced by the *Network Service Provider*.

(b) The *Network Service Provider* may provide any information it so receives to any *User* who intends to *connect* any equipment to the *transmission or distribution system* for the purposes of enabling that *User* to undertake any *power system* simulation studies it wishes to undertake, subject to that *User* entering into a confidentiality agreement with the *Network Service Provider*, to apply for the benefit of the *Network Service Provider* and any *User* whose information is so provided, in such form as the *Network Service Provider* may require.

3.2.5 Technical matters to be coordinated

A *User* and the *Network Service Provider* must agree upon the following matters for each new or altered *connection*:

(a) design at the *connection point*;

(b) *protection*;

(c) control characteristics;

(d) communications, remote controls, indications and alarms;

(e) insulation co-ordination and lightning *protection*;

(f) fault levels and *total fault clearance times*;

(g) switching and isolation *facilities*;

(h) interlocking arrangements;

(i) synchronising *facilities*;

(j) provision of information;

(k) computer model and *power system* simulation study requirements;

(l) *load shedding* and islanding schemes;

(m) any special test requirements, and

(n) *generator performance standards* for *large generating systems*.

3.2.6 Register of performance requirements

(a) The *Network Service Provider* will maintain a '*User* Performance Register' documenting the *generator performance standards* for each *large generating system* developed through the process defined in clause 3.3.4. The '*User* Performance Register' will also capture the key technical requirements for *large loads*.

> **Note:**
> The register required in this clause 3.2.6 is intended to align with, and not duplicate, the *Generator* Register required in the *WEM Rules.*

(b) The '*User* Performance Register' should include any information considered relevant by the *Network Service Provider* and must record, at a minimum, for each *large generating system* for which *generator performance standards* have been agreed through the process defined in clause 3.3.4:

(1) the status of connection;

(2) details of the *Generator* responsible for the *large generating system*;

(3) full details of each *generator performance standard* for each *generating unit* or component of the *generating system*, including *trigger events*;

(4) the *generating system* model provided by the *Generator*; and

(5) each compliance monitoring program agreed by the *Network Service Provider* under clause 4.1.3(b).

(c) A *Generator* responsible for a *large generating system* for which *generator performance standards* have been agreed through the process defined in clause 3.3.4 must notify the relevant *Network Service Provider* as soon as reasonably practicable of any *changes* in respect of the *generating system*, the *generator performance standards*, the *generating system* model, the ownership of the *generating system* or any other information in respect of the *large generating system* that would render the information, recorded in the register, being inaccurate or out of date.

(d) The *Network Service Provider* must make the register available on request to:

(1) a *User*, but only in respect of the information that relates to a *large generating system* or *large load* that the *User* is responsible for;

(2) *AEMO*; and

(3) the *Authority*.

3.2.7 Changes to control and *protection* settings

(a) The *Network Service Provider* may undertake a review of the control and *protection* system settings within a *User's facility* to determine whether there is a need for any modification to those settings to improve *power system security*, *power system reliability* or the *quality of supply* to other *Users*.

(b) Where the review completed in accordance with clause 3.2.7(a) identifies a need to alter existing settings the *User* must make any *changes* requested.

3.2.8 Other installation requirements

(a) *Users* connecting to the *distribution system* must design their *facilities* to comply with the *WA Service and Installation Requirements*.

3.3 REQUIREMENTS FOR CONNECTION OF LARGE GENERATING SYSTEMS TO THE TRANSMISSION SYSTEM OR THE HIGH VOLTAGE DISTRIBUTION SYSTEM

3.3.1 Overview

This clause 3.3 addresses the requirements for the connection of *large generating units* and *large generating systems* of aggregate rated capacity greater than 5 MVA to the *transmission system* or the *high voltage distribution system*. This does not apply to the connection of *small generating systems* for which requirements are provided for in clauses 3.5, 3.7 or 3.8.

Note:
This clause 3.3 allows for the *Network Service Provider* to consult with *AEMO*:
- prior to accepting negotiated *generator performance standards*;
- when deciding whether a *potential relevant generator modification* is to be classified as a *relevant generator modification;* and
- when assessing the sufficiency of *Generator* system models.

3.3.2 General requirements

(a) A *Generator* responsible for a *large generating system* must comply at all times with applicable requirements and conditions of *connection* for *large generating systems* as set out in this clause 3.3.

(b) A *Generator* responsible for a *large generating system* must operate *facilities* and equipment in accordance with *directions* given by *AEMO* and the *Network Service Provider* under these *Rules* or under any *written law*.

(c) A *generating unit* must have equipment characteristics and *control systems*, including the inertia (effective, presented to the *power system*), short-circuit ratio and *power system* stabilisers, sufficient not to cause any reduction of *power transfer capability* because of:

(1) transient stability or oscillatory stability;

(2) *unacceptable frequency conditions*; or

(3) *unacceptable voltage conditions*,

relative to the level necessary to *supply* the *load connected* to the *power system.*

Note:
The effect of this clause is to prevent *generating units* being permitted to connect to the *transmission or distribution system* if, as a result of the connection of those *generating units,* the *power transfer capability* of the *power system* will be reduced such that it would impede the ability to *supply load*.

(d) An unplanned trip of a *generating unit* must not cause an increased need for *load shedding* because of:

(1) *rate of change of frequency*;

(2) magnitude of *frequency* excursion;

(3) *active power* imbalance;

(4) *reactive power* imbalance; or

(5) displacement of reactive capability,

over and above the level that would apply if the *generating unit* was not *connected*.

Note:
The effect of this clause is to limit the maximum *generating unit* size that is permitted to connect to the *transmission or distribution system* without taking an appropriate action to rectify the potential problem.

(e) A *Generator* must ensure that its transients do not adversely affect the *Network Service Provider* and other *Users*.

(f) Unless otherwise specified in these *Rules*, the technical requirements for *generating systems* apply at the *connection point*.

(g) A *Generator* responsible for a *large generating system connected to the transmission system* must comply at all times with *protection* requirements specified in clause 3.5.1 and 3.5.2.

(h) A *Generator* responsible for a *large generating system connected* to the *high voltage distribution system* must comply at all times with *protection* requirements specified in clause 3.5.1 and 3.5.3.

3.3.3 Provision of information

(a) A *Generator* must provide all data reasonably required by the *Network Service Provider* to assess the impact of a *generating unit* on *transmission and distribution systems* performance and *power system security*.

(b) Details of the kinds of data that may be required are included in Attachment 3, Attachment 4, Attachment 5, Attachment 6, Attachment 7 and Attachment 8.

3.3.4 Establishing *generator performance standards*

3.3.4.1 General Provisions

(a) A *Generator* seeking to connect a *large generating system* to the *power system* must establish a set of *generator performance standards* that specify the technical performance requirements for the *generating system* either by applying the process defined in this clause 3.3.4 or through the process defined in clause 3A of the *WEM Rules,* unless granted an exemption under clause 3A.3.1 of the *WEM Rules.*

Note:
For clarity, if a *large generating system* receives an exemption under clause 3A.3.1 of the *WEM Rules,* they do not need to negotiate *generator performance standards* under these *Rules.* However, all other relevant sections of these *Rules* continue to apply.

3.3.4.2 Technical *Rules* process for establishing *generator performance standards*

(a) A *Generator* seeking to connect a *large generating system* must propose *generator performance standards* for the *generating system* addressing each of the technical requirements listed in clause 3.3.7. The *Generator* must submit the *proposed generator performance standards* to the *Network Service Provider*.

(b) The *generator performance standard* proposed for each technical requirement must be set to meet the *common requirements* and either:

(1) be equal to or better than the *ideal generator performance standard*; or

(2) if a *proposed negotiated generator performance standard* is submitted:

(A) be no less onerous than the *minimum generator performance standard*;

(B) demonstrate any applicable *negotiation criteria* have been met;

(C) meet the requirements of clause 3.3.4.2(e); and

(D) if applicable, meet the requirements of clause 3.3.4.2(f).

(c) The *Network Service Provider* must not approve a *proposed generator performance standard* that does not meet or demonstrate the applicable criteria listed in clause 3.3.4.2(b)

(d) The *Network Service Provider* must approve a *proposed generator performance standard* that is equal to or better than the *ideal generator performance standard* for a technical requirement.

(e) A *proposed negotiated generator performance standard* must be as consistent as practicable to the corresponding *ideal generator performance standard* for that technical requirement, having regard to:

(1) the need to protect the *large generating system* from damage;

(2) *power system* conditions at the location of the *connection* or proposed *connection*; and

(3) the commercial and technical feasibility of complying with the *ideal generator performance standard*.

(f) A *proposed negotiated generator performance standard* may include a *trigger event* which must address:

(1) the conditions for determining whether the *trigger event* has occurred;

(2) the party responsible for determining whether the *trigger event* has occurred;

(3) the actions required to be taken and any revised *generator performance standards* which must be achieved if the *trigger event* occurs;

(4) the maximum timeframe for compliance with any action required to be taken and each revised *generator performance standard* following the *trigger event*;

(5) any requirements to provide information and supporting evidence required by the *Network Service Provider* or *AEMO* to demonstrate that, if the *trigger event* occurs, the actions required will occur and will deliver the agreed outcome and level of performance required by any revised *generator performance standard*;

(6) any testing requirements to verify compliance with each revised *generator performance standard*; and

(7) any requirements necessary to verify that the actions required to be taken have occurred if the *trigger event* occurs.

(g) If a r*egistered generator performance standard* includes a *trigger event* and the *trigger event* subsequently occurs, the *Generator* responsible for the *large generating system* must comply with the requirements of the *trigger event*.

(h) A *trigger event* contained in a r*egistered generator performance standard* may be modified by written agreement between the *Generator* responsible for the *large generating system* and the *Network Service Provider.*

(i) If a *Generator* responsible for *a large generating system* submits to the *Network Service Provider* a *proposed negotiated generator performance standard* pursuant to clause 3.3.4.2(b) or clause 3.3.6(a)(1), the *Generator* must provide to the *Network Service Provider*:

(1) the reasons and supporting evidence demonstrating why the *large generating system* cannot meet the *ideal generator performance standard*; and

(2) any information and supporting evidence required by the *Network Service Provider* setting out the reasons why the *proposed negotiated generator performance standard* is appropriate, including:

(A) how the *proposed negotiated generator performance standard* meets the applicable criteria listed in clause 3.3.4.2(b) ; and

(B) how the *Generator* has taken into account each of the matters listed in clause 3.3.4.2(e).

(j) If, following the receipt of a *proposed negotiated generator performance standard* and the information and evidence referred to in clause 3.3.4.2(i), the *Network Service Provider* reasonably considers it will approve the *proposed negotiated generator performance standard*, the *Network Service Provider* should consult with *AEMO* in relation to each *proposed negotiated generator performance standard* for technical requirements that the *Network Service Provider* considers will impact *power system security* or *power system reliability*.

(k) The *Network Service Provider* must determine whether to approve or reject each *proposed negotiated generator performance standard* proposed by the *Generator* for the *large generating system*.

(l) The *Network Service Provider* must reject a *proposed negotiated generator performance standard* where:

(1) in the *Network Service Provider's* reasonable opinion one or more of the requirements in clause 3.3.4.2(b)(2) are not met;

(2) the *Network Service Provider* has consulted with *AEMO* and *AEMO* has recommended that the *Network Service Provider* reject the *proposed negotiated generator performance standard*; or

(3) in the *Network Service Provider's* reasonable opinion, the *proposed negotiated generator performance standard* will adversely affect:

(A) *power system security*;

(B) *power system reliability*;

(C) *power transfer capability*; or

(D) the *quality of supply* of electricity for other *Users*.

(m) If the *Network Service Provider* rejects a *proposed negotiated generator performance standard*, the *Network Service Provider* must provide to the *Generator* responsible for the *large generating system*:

(1) written reasons for the rejection;

(2) any recommendation provided by *AEMO* to the *Network Service Provider* in respect of a suitable alternative *generator performance standard* for a technical requirement; and

(3) if applicable, an alternative *proposed negotiated generator performance standard* that the *Network Service Provider* considers meets the requirements of clause 3.3.4.2(b)(2), which may include a *trigger event*.

(n) The *Generator* responsible for the *large generating system* may, in relation to an alternative *proposed negotiated generator performance standard* provided by the *Network Service Provider* in accordance with clause 3.3.4.2(m)(3), either:

(1) accept the alternative *proposed negotiated generator performance standard*; or

(2) reject the alternative *proposed negotiated generator performance standard*; and

(A) propose a different alternative *proposed negotiated generator performance standard* consistent with the requirements of clause 3.3.4.2(b)(2), which may include a *trigger event*, in which case the process for consideration and approval of *proposed generator performance standards* in clause 3.3.4 applies; or

(B) elect to adopt the *ideal generator performance standard* for the relevant technical requirement.

(o) When a *proposed generator performance standard* is approved in accordance with clause 3.3.4.2(k), or accepted by the *Generator* under clause 3.3.4.2(n)(1), it must be recorded by the relevant *Network Service Provider* on the register developed in accordance with clause 3.2.6.

(p) A *Generator* must verify compliance of its own equipment with the *generator performance standards* developed through the process defined in this clause 3.3.4.2 by the methods described in clause 4.1.3.

3.3.5 *Potential relevant generator modifications* to existing *generating systems*

(a) Clauses 3.3.5 and 3.3.6 do not apply when a *Generator* undertakes a modification to a *large generating system* that is declared a Relevant Generator Modification in accordance with clause 3A.13.4 of the *WEM Rules.*

> **Note:**
> The purpose of this clause is to clarify that if the *large generating system* has agreed *generator performance standards* under the *WEM Rules*, the provisions related to Relevant Generator Modification under the *WEM Rules* apply. However, all other relevant sections of these *Rules* continue to apply.

(b) A *potential relevant generator modification* means for the purposes of clauses 3.3.5 and 3.3.6, a modification to a *large generating system* that:

(1) has the potential, or may be likely, to materially impact or *change* any of the characteristics, performance or capacity of the *generating system* in respect of a technical requirement addressed by clause 3.1(e), 3.3 or 3.5;

(2) has the potential to alter the capacity of the *large generating system* in respect of any technical requirement for which the *ideal generator performance standard* has been amended since the applicable *generator performance standard* was approved;

(3) is reasonably considered to require an amendment to the *Generator's connection agreement* for the *generating system*; or

(4) requires submission of a connection application in accordance with the *Network Service Provider*'s policy for *access* to its network,

(c) A *Generator* responsible for a *large generating system* must notify the *Network Service Provider* prior to undertaking a *potential relevant generator modification*.

(d) Subject to clause 3.3.5(e) and clause 3.3.5(f), the *Network Service Provider* may declare a *potential relevant generator modification* to be a *relevant generator modification*.

(e) Where the *Network Service Provider* is notified of a *potential relevant generator modification* to a *large generating system* in accordance with clause 3.3.5(c), the *Network Service Provider* may consult with *AEMO* before making a decision whether or not to declare the *potential relevant generator modification* a *relevant generator modification*.

(f) The *Network Service Provider* must declare a *potential relevant generator modification* to be a *relevant generator modification* where *AEMO* advises the *Network Service Provider* that the *potential relevant generator modification* should be declared a *relevant generator modification*.

(g) If the *Network Service Provider* declares a *potential relevant generator modification* to be a *relevant generator modification*, the *Network Service Provider* must notify the *Generator* responsible for the *generating system*.

(h) If the *Network Service Provider* does not declare the *potential relevant generator modification* to be a *relevant generator modification*, the *Generator* may undertake the *potential relevant generator modification* as notified to the *Network Service Provider* subject to any other requirements or obligations that apply to the *Generator* under its *connection agreement*, arrangement for *access*, the *Access Code*, the *Rules* or any applicable law.

3.3.6 Relevant *generator modifications* to existing *generating systems*

(a) If the *Network Service Provider* declares a *potential relevant generator modification* to be a *relevant generator modification*, the *Generator* responsible for the *large generating system* must submit:

(1) *proposed generator performance standards* addressing each technical requirement in accordance with clause 3.3.4.2(b) prior to undertaking the *relevant generator modification*; and

(2) a compliance monitoring program in accordance with clause 4.1.3(b),

for the *large generating system*.

(b) Where a *Generator* submits *proposed generator performance standards*, the process for consideration and approval of *proposed generator performance standards* in clause 3.3.4 applies.

(c) Where the *Network Service Provider* has declared a *proposed relevant generator modification* to be a *relevant generator modification*, the *Network Service Provider* may:

(1) on and from the date that works in respect of the *relevant generator modification* is scheduled to be undertaken or commence, revoke the *large generating system*'s *approval to operate*; or

(2) require the *large generating system* to conduct commissioning tests and, if the *Network Service Provider* is not satisfied with the results of the commissioning tests, revoke the *large generating system*'s *approval to operate*, and

(3) require the *Generator* to obtain an *interim approval to operate* (with or without conditions) or an *approval to operate*, and the process in clause 4.2.2, as relevant, applies.

3.3.7 Technical requirements addressed by *generator performance standards*

3.3.7.1 General

(a) Clause 3.3.7 lists each of the technical requirements for *large generating systems* addressed by *generator performance standards*. An *ideal generator performance standard, minimum generator performance standard* and any applicable *common requirements* are defined for each technical requirement.

(b) Each technical requirement may specify *negotiation criteria* which must be met if a *Generator* responsible for a *large generating system* submits a *proposed negotiated generator performance standard*.

(c) If a technical requirement specifies *common requirements*, these apply whether an *ideal generator performance standard* or *negotiated generator performance standard* is intended to apply to a *large generating system* in respect of a technical requirement.

3.3.7.2 *Active power* capability

(a) *Common requirements*

(1) In relation to the application of this technical requirement, the requirements apply at the *connection point* unless otherwise specified in the relevant clause, or the *Network Service Provider* determines that the technical requirement must be measured at a different location for the particular *generating unit* or *generating system*, in which case the measurement location must be recorded as part of the relevant *generator performance standard*.

(b) *Ideal generator performance standard*

(1) The *ideal generator performance standard* is the same as the *minimum generator performance standard* for *active power* capability.

(c) *Minimum generator performance standard*

(1) The *generator performance standard* for *active power* capability must include *temperature dependency data* up to and including the *maximum temperature*, which must include the *rated maximum active power*, and including ambient temperatures above the *maximum temperature* after which the *active power* capability is reduced:

(A) for the *generating system* measured at the *connection point*; and

(B) for each synchronous *generating unit* measured at the *generating unit* terminal.

(2) Subject to clause 3.3.7.2(c)(3) and energy source availability, the *generating unit* or *generating system*, as applicable, must be capable of maintaining *continuous uninterrupted operation* while achieving and maintaining the relevant *active power* output levels at the temperatures specified in clause 3.3.7.2(c)(1).

(3) Clause 3.3.7.2(c)(2) does not apply to the extent that a temporary reduction in *active power* has been agreed to by the *Network Service Provider* in order to achieve the required *reactive power capability* under maximum ambient temperature conditions as set out in clause 3.3.7.3.

(4) Unless otherwise directed by the *Network Service Provider generating systems* and *generating units*, as applicable, must not exceed the relevant *active power* levels at the temperatures specified in clause 3.3.7.2(c)(1).

(d) *Negotiation criteria*

(1) There are no *negotiation criteria* for this technical requirement.

3.3.7.3 *Reactive power* capability

(a) *Common requirements*

(1) In relation to the application of this technical requirement, the requirements apply at the *connection point* unless otherwise specified in the relevant clause, or the *Network Service Provider* determines that the technical requirement must be measured at a different location for the particular *generating unit* or *generating system*, in which case the measurement location must be recorded as part of the relevant *generator performance standard*. The *generator performance standard* must include a *generator performance chart*, including data up to and including the *maximum temperature*, and including ambient temperatures above the *maximum temperature* after which the performance is reduced.

(2) There must be no *control system* limitation, *protection* system or other limiting device in operation that would prevent the *generating system* from providing the *reactive power* output within the area defined in the *generator performance chart*.

(3) Each *generating system*'s *connection point* must be capable of permitting the *dispatch* of the full *active power* and *reactive power* capability of the *generating system*.

(b) *Ideal generator performance standard*

(1) For all operating conditions, including at temperatures up to and including the *maximum temperature*, each *generating unit* within the *generating system* must be capable of supplying or absorbing *reactive power* continuously of at least the amount equal to the product of the *rated maximum active power* output of the *generating unit* at nominal *voltage* and 0.484 while operating at any level of *active power* output between its maximum *active power* output level and its minimum *active power* output level as specified in the

temperature dependency data under 3.3.7.2, and its *rated* minimum *active power* output level.

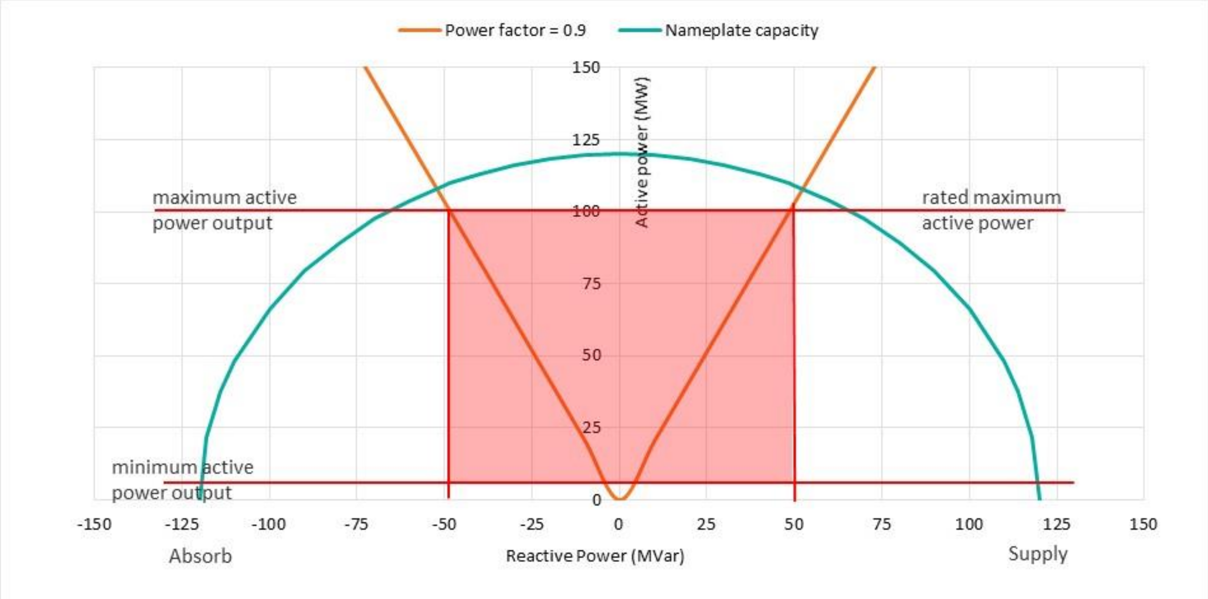

Figure 3-1 Example *reactive power capability* required to meet *ideal generator performance standard*

(2) The required levels of *reactive power capability* must be able to be delivered continuously for *voltage*s at the *connection point* within the allowable *steady state voltage* ranges as specified in clause 2.2 of these *Rules*.

(c) *Minimum generator performance standard*

(1) Subject to clause 3.3.7.3(c)(3), for all operating conditions, including at temperatures up to and including the *maximum temperature*, the *generating system* must be capable of supplying or absorbing *reactive power* continuously of at least the amount equal to the product of the *rated maximum active power* output of the *generating system* and 0.329 while operating at any level of *active power* output level between its maximum *active power* output level as specified in the *temperature dependency data* under 3.3.7.2, and *rated minimum active power* output level.

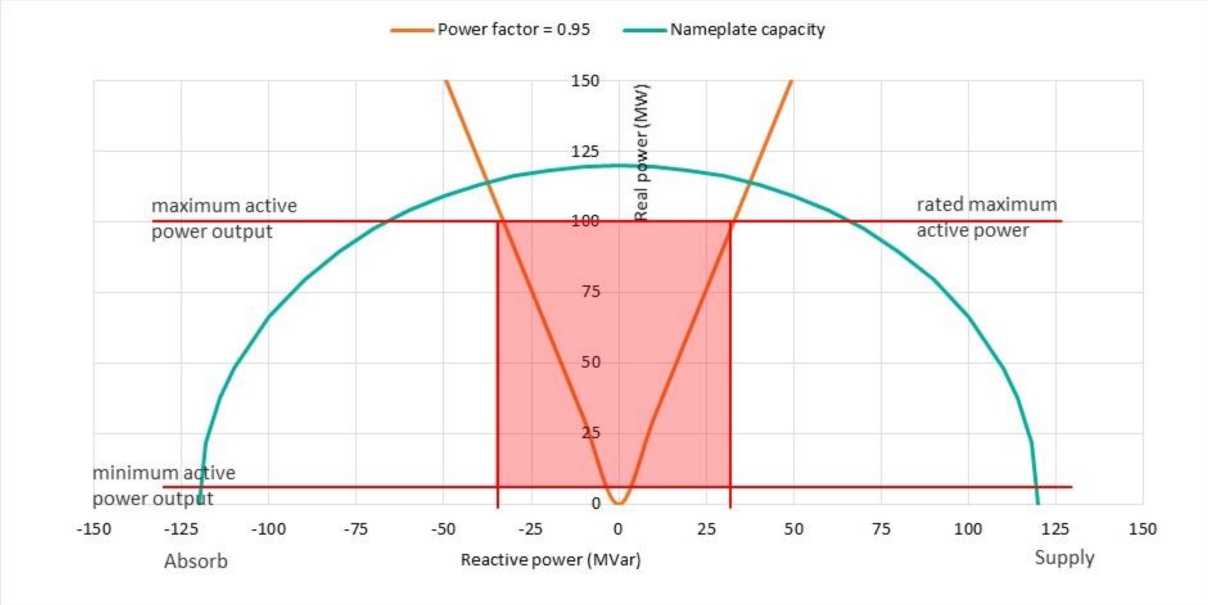

Figure 3-2 Example *reactive power capability* required to meet the *minimum generator performance standard*

(2) The *reactive power capability* may be varied as shown in Figure 3-3 when the *voltage* at the *connection point* varies between 0.9 per unit and 1.1 per unit, where the *generating system* must be capable of absorbing or supplying *reactive power* continuously when operating anywhere inside the curve specified in Figure 3-3.

Figure 3-3 Relaxation of *reactive power* requirement with *connection point voltage*

(3) *Generating systems* containing *intermittent generating systems* may, with the *Network Service Provider's* agreement, achieve the *reactive power capability* specified in clause 3.3.7.3(c)(1) by reducing *active power* output when the ambient temperature exceeds 25 degrees Celsius in their location, with the conditions forming part of the *generator performance standard*.

(d) *Negotiation criteria*

(1) There are no *negotiation criteria* for this technical requirement.

3.3.7.4 *Voltage* and *reactive power* control

(a) *Common requirements*

(1) In relation to the application of this technical requirement, the requirements apply at the *connection point* unless otherwise specified in the relevant clause, or the *Network Service Provider* determines that the technical requirement must be measured at a different location for the particular *generating unit* or *generating system*, in which case the measurement location must be recorded as part of the relevant *generator performance standard*.

(2) In relation to the application of this technical requirement, unless otherwise specified in the relevant clause, the requirements apply when operating at any *active power* and *reactive power* level as permitted or required under these *Rules*, and at all temperatures up to and including the *maximum temperature*.

(b) *Ideal generator performance standard*

(1) The *ideal generator performance standard*, as it applies to different *generating systems*, is specified in Table 3-3.

Table 3-3 *Voltage* and *reactive power* control *ideal generator performance standard*

Type of *generating system*	**Relevant requirement**
generating system comprised solely of *synchronous generating units*.	Clause 3.3.7.4(b)(2) and clause 3.3.7.4(b)(3).
generating system comprised solely of *asynchronous generating units*.	Clause 3.3.7.4(b)(2) and clause 3.3.7.4(b)(4).
generating system comprised of *synchronous generating units* and *asynchronous generating units*.	Clause 3.3.7.4(b)(2) and: (a) for that part of the *generating system* comprised of *synchronous generating units*, clause 3.3.7.4(b)(3); (b) for that part of the *generating system* comprised of *asynchronous generating units*, clause 3.3.7.4(b)(4).

(2) All *generating systems*

(A) The *generating system* must have equipment capabilities and *control systems*, including, if necessary, a *power system* stabiliser, sufficient to ensure that:

(i) *power system* oscillations, for the frequencies of oscillation of the *generating system* against any other *generating system* or device, are *adequately damped*;

(ii) operation of the *generating system* does not degrade the damping of any critical mode of oscillation of the *power system*; and

(iii) operation of the *generating system* does not cause instability (including hunting of *tap-changing transformer control systems*) that would adversely impact other equipment *connected* to the *power system*.

(B) *Control systems* on *generating systems* that control *voltage* and *reactive power* must include permanently installed and operational, monitoring and recording equipment for key variables including each input and output, and equipment for testing the *control systems* sufficient to establish their dynamic operational characteristics.

(C) A *generating system* must have *control systems* capable of regulating *voltage*, *reactive power* and *power factor*, with the ability to:

(i) operate in all control modes; and

(ii) switch between control modes, as demonstrated to the reasonable satisfaction of the *Network Service Provider*. Where a *generating system* has been commissioned with more than one control mode, a procedure for switching between control modes must be agreed with the *Network Service Provider* as part of the *generator performance standard*.

(D) A *generating system* must have a *voltage control system* that:

(i) regulates *voltage* to within 0.5% of the *target setpoint*, where that setpoint may be adjusted to incorporate any *voltage* droop or reactive current compensation agreed with the *Network Service Provider*;

(ii) regulates *voltage* in a manner that helps to support network *voltage*s during faults and does not prevent the requirements for *voltage* performance and stability in the *Rules* from being achieved;

(iii) allows the *voltage* to be continuously *controllable* in the range of at least 95% to 105% of the target *voltage* (as determined by the *Network Service Provider*), without reliance on a *tap-changing transformer* and subject to the *generator performance standards* for *reactive power capability* with the *voltage* control location agreed with the *Network Service Provider*; and

(iv) has limiting devices to ensure that a *voltage* disturbance does not cause a *generating unit* to trip at the limits of its operating capability. The *generating system* must be capable of stable operation for indefinite periods while under the control of any limiter. Limiters must not detract from the performance of any stabilising circuits and must have settings applied which are coordinated with all *protection systems*.

(E) Where installed, a *power system* stabiliser must have:

(i) two washout filters for each input, with ability to bypass one of them if necessary;

(ii) sufficient (and not less than two) lead-lag transfer function blocks (or equivalent number of complex poles and zeros) with adjustable gain and time-constants, to compensate fully for the phase lags due to the *generating unit*;

(iii) monitoring and recording equipment for key variables including inputs, output and the inputs to the lead-lag transfer function blocks; and

(iv) equipment to permit testing of the *power system* stabiliser in isolation from the *power system* by injection of test signals, sufficient to establish the transfer function of the *power system* stabiliser.

(F) A *reactive power*, including a *power factor*, *control system* must:

(i) regulate *reactive power* or *power factor* (as applicable) to within:

- for a *generating system* operating in *reactive power* mode, 2% of the *rated maximum apparent power* of the *generating system* from the *target setpoint*; or

- for a *generating system* operating in *power factor* mode, a *power factor* equivalent to 2% of the *rated maximum apparent power* of the *generating system* from the *target setpoint*; and

(ii) allow the *reactive power* or *power factor target setpoint* to be continuously *controllable* across the *reactive power capability* range specified in the relevant *generator performance standard*.

(G) The structure and parameter settings of all components of the *control system*, including the *voltage* regulator, *reactive power* regulator, *power system* stabiliser, power amplifiers and all associated limiters, must be approved by the *Network Service Provider* as part of the *generator performance standard*.

(H) Each *control system* must be *adequately damped*.

(3) *Synchronous generating systems*

(A) Each *synchronous generating unit* must have an *excitation control system* that:

(i) is capable of operating the stator continuously at 105% of nominal *voltage* when operating at the maximum *active power* output specified in the *temperature dependency data* provided under 3.3.7.2 for the relevant temperature;

(ii) has an excitation ceiling *voltage* of at least:

- for a *static excitation system*, 2.3 times; or
- for other *excitation control systems*, 1.5 times,

the excitation required to achieve *generation* at the *nameplate rating* for rated *power factor*, rated speed and nominal *voltage*;

> **Note:**
> This clause does not align with the equivalent clause in Appendix 12 of the *WEM Rules* that applies to Transmission Connected Generating Systems. For the *generation* expected to connect under these *Rules*, this drafting is more appropriate.

(B) has a *power system* stabiliser with sufficient flexibility to enable damping performance to be maximised, with the stabilising circuit responsive and adjustable over a *frequency* range from 0.1 Hz to 2.5 Hz; and

(C) achieves a minimum equivalent gain of 200.

> **Note:**
> For both proportional and integral control actions. Note that one per unit excitation *voltage* is that field *voltage* required to produce nominal *voltage* on the air gap line of the *generating unit* open circuit characteristic (refer IEEE Standard 115-1983 - Test Procedures for Synchronous Machines).

(D) The performance characteristics required for AC exciter, rotating rectifier and *static excitation systems* are specified in Table 3-4.

Table 3-4 *Synchronous generating unit excitation control system* performance requirements

Performance item	Units	Static excitation	AC exciter or rotating rectifier	Notes
generating unit* field *voltage rise time: Time for field *voltage* to rise from rated field *voltage* to excitation ceiling *voltage* following the application of a short duration impulse to the *voltage* reference.	Second	0.05 maximum	0.5 maximum	1 and 2

Settling time with the *generating unit* unsynchronised following a disturbance equivalent to a 5% *voltage step change* in the sensed *generating unit* terminal.	Second	1.5 maximum	2.5 maximum	2
Settling time with the *generating unit* synchronised following a disturbance equivalent to a 5% *voltage step change* in the sensed *generating unit* terminal. It must be met at all operating points within the *generating unit* capability.	Second	2.5 maximum	5 maximum	2
Settling time following any disturbance which causes an excitation limiter to operate.	Second	5 maximum	5 maximum	2
Notes: 1. Rated field *voltage* is that *voltage* required to give nominal *generating unit* terminal *voltage* when the *generating unit* is operating at its *rated maximum apparent power.* 2. For rotating rectifier excitation system where the field *voltage* is not accessible for direct measurement, the main exciter field *voltage* must comply with this clause.				

(E) Where provided, a *power system* stabiliser must have:

(i) measurements of rotor speed and *active power* output of the *generating unit* as inputs; and

(ii) an output limiter, which is continually adjustable over the range of –10% to +10% of stator *voltage*.

(4) *Asynchronous generating systems*

(A) A *generating system*, comprised of *asynchronous generating units*, must have a *voltage* and *reactive power control system* that has a power oscillation damping capability with sufficient flexibility to enable damping performance to be maximised, with the stabilising circuit responsive and adjustable over a *frequency* range from 0.1 Hz to 2.5 Hz. Any *power system* stabiliser must have measurements of *power system frequency* and *active power* output of the *generating unit* as inputs.

(B) A *generating system*, comprised of *asynchronous generating units*, must have a *control system* capable of achieving a minimum equivalent gain of 200.

(C) The performance characteristics required for the *voltage* and *reactive power control systems* of all *asynchronous generating systems* are specified in Table 3-5.

Table 3-5 *Asynchronous generating system control system* performance requirements

Performance item	Units	Limiting value	Notes
Rise Time: Time for the controlled parameter (*voltage* or *reactive power* output) to rise from the initial value to 90% of the change between the initial value and the final value following the application of a 5% step change to the *control system* reference.	second	1.5 maximum	1 and 3
Settling time of the controlled parameter with the *generating system connected* to the *transmission system* following a step change in the *control system* reference such that it is not large enough to cause saturation of the controlled output parameter. It must be met at all operating points within the *generating unit*'s capability.	second	2.5 maximum	1, 2 and 3
Settling time of the controlled parameter with the *generating system connected* to the *transmission system* following any disturbance that is large enough to cause the maximum value of the controlled output parameter to be just exceeded.	second	5 maximum	2 and 3
Notes: 1. The step change is 5%, or a lesser value specified by the *Network Service Provider* such that it is the largest step change that results in the required *settling time* at the *connection point*. 2. The step change is specified by the *Network Service Provider* such that it is the largest step change that results in the required *settling time* at the *connection point*. 3. The step change is to be recorded for future assessment.			

(D) The controlled parameters used to meet the requirements specified in Table 3-5 and measurement of the parameters must be agreed with the *Network Service Provider* as part of the *generator performance standard*.

(c) *Minimum generator performance standard*

(1) The *minimum generator performance standard* for *voltage* and *reactive power* control as it applies to different *generating systems*, is specified in Table 3-6

Table 3-6 *Voltage* and *reactive power* control *minimum generator performance standard*

Type of *generating system*	**Relevant requirement**
generating system comprised solely of *synchronous generating units*.	Clause 3.3.7.4(c)(2) and clause 3.3.7.4(c)(3)
generating system comprised solely of *asynchronous generating units*.	Clause 3.3.7.4(c)(2) and clause 3.3.7.4(c)(4).
generating system comprised of *synchronous generating units* and *asynchronous generating units*.	Clause 3.3.7.4(c)(2) and: (a) for that part of the *generating system* comprised of *synchronous generating units*, clause 3.3.7.4(c)(3); (b) for that part of the *generating system* comprised of *asynchronous generating units*, clause 3.3.7.4(c)(4).

(2) All *generating systems*

(A) A *generating system* must have equipment capabilities and *control systems*, including, if necessary, a *power system* stabiliser, sufficient to ensure that:

(i) *power system* oscillations, for the frequencies of oscillation of the *generating system* against any other *generating system* or device, are *adequately damped*;

(ii) operation of the *generating system* is *adequately damped*; and

(iii) *control systems* can be sufficiently tested to establish their dynamic operational characteristics.

(B) A *generating system* must have a *control system* to regulate:

(i) *voltage*; or

(ii) either of *reactive power* or *power factor*, with the agreement of the *Network Service Provider*.

(C) A *voltage control system* for a *generating system* must:

(i) regulate *voltage* to within 2% of the *target setpoint*, where that setpoint may be adjusted to incorporate any *voltage* droop or reactive current compensation agreed with the *Network Service Provider*; and

(ii) allow the *voltage target setpoint* to be *controllable* in the range of at least 98% to 102% of the target *voltage* (as determined by the *Network Service Provider*) as specified by the *Network Service Provider*, subject to the *reactive power* *capability* agreed with the *Network Service Provider* under clause 3.3.7.3.

(D) A *generating system*'s *reactive power* or *power factor control system* must:

(i) regulate *reactive power* or *power factor* (as applicable) to within:

- for a *generating system* operating in *reactive power* mode, 5% of the *rated maximum apparent power* of the *generating system* from the *target setpoint*; or
- for a *generating system* operating in *power factor* mode, a *power factor* equivalent to 5% of the *rated maximum apparent power* of the *generating system* from the *target setpoint*;

(ii) allow the *reactive power* or *power factor target setpoint* to be continuously *controllable* across the *reactive power capability* defined in the relevant *generator performance standard*; and

(iii) have limiting devices to ensure that a *voltage* disturbance does not cause a *generating unit* to trip at the limits of its operating capability. The *generating system* must be capable of stable operation for indefinite periods while under the control of any limiter. Limiters must not detract from the performance of any stabilising circuits and must have settings applied, which are coordinated with all *protection systems*, and must be included as part of the *generator performance standard*.

(3) *Synchronous generating systems*

(A) Each *synchronous generating unit* within the *generating system*, with an excitation *control system* required to regulate *voltage* must:

(i) have excitation ceiling *voltage* of at least 1.5 times the excitation required to achieve generation at the nameplate *rating* for rated *power factor*, rated speed and nominal *voltage*; and

> **Note:**
> This clause does not align with the equivalent clause in Appendix 12 of the *WEM Rules* that applies to Transmission Connected Generating Systems. For the *generation* expected to connect under these *Rules*, this drafting is more appropriate.

(ii) subject to the ceiling *voltage* requirement, have a *settling time* of less than 7.5 seconds for a 5% *voltage* disturbance with the *generating unit* synchronised, subject to the *generating unit* operating at a point where such a *voltage* disturbance would not cause any limiting device to operate.

(4) Asynchronous *generating systems*

(A) A *generating system*, comprised of *asynchronous generating units*, with a *voltage control system* must have a *settling time* of less than 7.5 seconds for a 5% *voltage* disturbance subject to the *generating unit* being electrically *connected* to the *power system* and operating at a point where such a *voltage* disturbance would not cause any limiting device to operate.

(d) *Negotiation criteria*

(1) A *proposed negotiated generator performance standard* must be the highest level that the *generating system* can reasonably achieve, including by installation of additional dynamic *reactive power* equipment, and through optimising its *control systems*.

3.3.7.5 *Active power* control

(a) *Common requirements*

(1) All *generating systems* must be capable of meeting the *dispatch systems requirements* defined in the *WEM Rules* or, where the *dispatch system requirements* are deemed not relevant by the *Network Service Provider*, agree alternative arrangements with the *Network Service Provider* in consultation with *AEMO.*

(2) Any arrangements put in place as part of the arrangement for *access* to limit *active power* output in order to manage *constraints* on the network must be included as part of the *generator performance standard*.

(3) Each *control system* must be *adequately damped*.

(4) Any relevant *disconnection* settings must be included as part of the *generator performance standard*.

(5) Subject to energy source availability and any other agreement by the *Network Service Provider*, where *dispatched* by *AEMO* a *generating system* must be capable of maintaining its *active power* output consistent with its last received *dispatch* level in the event *remote monitoring equipment, remote control equipment*, or communication equipment are unavailable.

(6) The requirements in this clause 3.3.7.5 do not override any specific *active power* ramping requirements specified in clause 3.3.7.6 in response to *frequency* deviations.

(7) In relation to the application of this technical requirement, unless otherwise specified in the relevant clause, the requirements apply when operating at any *active power* and *reactive power* level as permitted or required under these *Rules*, and at all temperatures up to and including the *maximum temperature*.

(b) *Ideal generator performance standard*

(1) A *non-intermittent generating system* must have an *active power control system* capable of:

(A) maintaining and changing its *active power* output in accordance with *target setpoints;*

(B) ramping its *active power* output linearly from one *target setpoint* to another; and

(C) changing *active power generation* in response to a *change* in *target setpoint* at a rate not less than 5% of its *rated maximum active power* per minute.

(2) Subject to energy source availability, an *intermittent generating system* must be able to change its *active power* output in accordance with *target setpoints*, and must not change its *active power* output at a rate greater than 10 MW per minute or 15% of the *rated maximum active power* per minute, whichever is the lower or as agreed with the *Network Service Provider*.

(c) *Minimum generator performance standard*

(1) A *non-intermittent generating system* must have an *active power control system* capable of maintaining and changing its *active power* output in accordance with a *target setpoint*, and must be capable of changing *active power* generation at a rate not less than 5% of its *rated maximum active power* per minute.

(2) Subject to energy source availability, an *intermittent generating system* must ensure that any change of *active power* output in a 5 minute period does not exceed a value agreed with the *Network Service Provider*.

(d) *Negotiation criteria*

(1) There are no *negotiation criteria* for this technical requirement.

3.3.7.6 Inertia and *frequency* control

(a) *Common requirements*

(1) All *control systems* must be *adequately damped*.

(2) The recorded maximum ramp rate for the *generating system* must be expressed as the change in *active power* (measured in MW) achievable across 6 seconds.

(3) Any relevant disconnection settings must be provided as part of the *generator performance standard*.

(4) *Control systems* on *generating systems* that control *active power* must include permanently installed and operational monitoring and recording equipment

for key variables including each input and output, and equipment for testing the *control system* sufficient to establish its dynamic operational characteristics.

(5) After having met the relevant requirements for altering and holding *active power* output to arrest and correct changes in *power system frequency*, the *generating system*, or *generating units* where relevant, must adhere to relevant requirements of clause 3.3.7.5 when returning to regular *active power* output.

(6) Unless otherwise agreed by the *Network Service Provider* and *AEMO*, protection or other schemes that disconnect the *generating system* or elements of the *generating system*, must not be used in order to meet the requirements of this clause 3.3.7.6.

(7) A *generating system* must:

(A) have an automatic variable *active power* control characteristic; and

(B) where the *generating system* contains a *generating unit* with *turbine control systems*, it must include equipment for both speed and *active power* control.

(8) All *generating units*, or the *generating system* as applicable, must operate in a mode in which it will automatically alter its *active power* output to arrest and correct to changes in *power system frequency*, unless instructed or otherwise approved for testing purposes by the *Network Service Provider* (in consultation with *AEMO*).

(9) The *frequency dead band* on each *generating unit*, or the *generating system*, as applicable, must be no greater than +/-0.025 Hz around 50.0 Hz.

(10) Unless otherwise stated in this clause 3.3.7.6, the overall required *frequency* response of each *generating unit*, or *generating system* as applicable, must be settable and be capable of:

(A) automatically achieving an increase in *active power* output proportional to a change in *power system frequency* of not less than 5% of the *maximum active power* specified in the *temperature dependency data* provided under 3.3.7.2 for each 0.1 Hz reduction in *power system frequency* from the lower level of *frequency dead band*, provided the output is above the *rated minimum active power*; and

(B) automatically achieving a reduction in *active power* output proportional to a change in *power system frequency* of not less than 5% of the maximum *active power* specified in the *temperature dependency data* provided under 3.3.7.2 for each 0.1 Hz increase in *power system frequency* from the upper level of *frequency dead band*, provided this does not require operation below the *rated minimum active power*

(11) The *frequency* response capability described in clause 3.3.7.6(a)(10):

(A) must not exhibit any step changes in *active power* as the *power system frequency* changes, unless otherwise agreed by the *Network Service Provider* under clause 3.3.7.6(a)(6);

(B) must commence responding with a delay no greater than that required to ensure stable operation or to allow for *control system* latency, as agreed by the *Network Service Provider* and *AEMO*;

(C) must not increase *active power* output in response to an increase in *power system frequency*; and

(D) must not decrease *active power* output in response to a decrease in *power system frequency*;

(12) In relation to the application of this technical requirement, the requirements apply at the *connection point* unless otherwise specified in the relevant clause, or the *Network Service Provider* determines that the technical requirement must be measured at a different location for the particular *generating unit* or *generating system*, in which case the measurement location must be recorded as part of the relevant *generator performance standard*.

(13) In relation to the application of this technical requirement, unless otherwise specified in the relevant clause, the requirements apply when operating at any *active power* and *reactive power* level as permitted or required under these *Rules*, and at all temperatures up to and including the *maximum temperature*.

(b) *Ideal generator performance standard*

(1) The *ideal generator performance standard* requires that control ranges, response times and sustain times are achieved for *generating units*, or the *generating system* as applicable, such that, subject to energy source availability:

(A) the required *frequency* response in clause 3.3.7.6(a)(10)(A) can be complied with for any initial output up to the maximum *active power* specified in the *temperature dependency data* provided under clause 3.3.7.2 for the relevant temperature;

(B) for *synchronous generating systems*, for any *frequency* disturbance where the change in *power system frequency* is sufficient to change the *active power* of the *generating system* by at least 5% of its *rated maximum active power*, the *generating unit* or *generating system* achieves at least 90% of the required *frequency* response specified in clause 3.3.7.6(a)(10) within 6 seconds; and

(C) for *asynchronous generating systems*, for any *frequency* disturbance where the change in *power system frequency* is sufficient to change the *active power* of the *generating system* by at least 5% of its *rated maximum active power*, the *generating unit* or *generating system* achieves at least 90% of the required *frequency* response specified in clause 3.3.7.6(a)(10) within 2 seconds;

(D) the required *frequency* response specified in clause 3.3.7.6(a)(10) is sustained for not less than a further 10 seconds beyond the timeframes specified in clause 3.3.7.6(b)(1)(B)and clause 3.3.7.6(b)(1)(C) as applicable, subject to a restoration of *power system frequency* in which case the *active power* output must be changed in proportion to the *power system frequency* in accordance with the required *frequency* response specified in clause 3.3.7.6(a)(10); and

(E) each *generating unit's* or *generating system's*, as applicable, capability to sustain response beyond the timeframe specified in clause 3.3.7.6(b)(1)(D) must be included as part of the relevant *generator performance standard.*

(c) *Minimum generator performance standard*

(1) Subject to energy source availability, a *generating system* is required to have control ranges and response times for each *generating unit*, or *generating systems* as applicable, such that:

(A) it is able to comply with the required *frequency* response specified in clause 3.3.7.6(a)(10)(A) for any initial output up to 85% of *rated maximum active power* output;

(B) for initial outputs above 85% of *rated maximum active power* output, each *generating unit's* or *generating system's*, as applicable, response capability must be agreed with the *Network Service Provider*, and included as part of the relevant *generator performance standard*; and

(C) for *synchronous generating systems*, for any *frequency* disturbance where the change in *frequency* is sufficient to change the *active power* of the *generating system* by at least 5% of its *rated maximum active power* output, the *generating unit* or *generating system* achieves at least 60% of the required *frequency* response specified in clause 3.3.7.6(a)(10) within 6 seconds, and 90% of the required *frequency* response specified in clause 3.3.7.6(a)(10) within 15 seconds;

(D) for *asynchronous generating systems*, for any *frequency* disturbance where the change in *frequency* is sufficient to change the *active power* of the *generating system* by at least 5% of its *rated maximum active power* output, the *generating unit* or *generating system* achieves at least 60% of the required *frequency* response specified in clause 3.3.7.6(a)(10)within 6 seconds, and at least 90% of the required *frequency* response specified in clause 3.3.7.6(a)(10) within 15 seconds;

(E) the required *frequency* response specified in clause 3.3.7.6(a)(10) is sustained for not less than a further 10 seconds beyond the latest timeframe specified in clause 3.3.7.6(c)(1)(C)and clause 3.3.7.6(c)(1)(D) as applicable, subject to a restoration of *power* *system frequency* in which case the *active power* output must be changed in proportion to the *power system frequency* in accordance with the required *frequency* response specified in clause 3.3.7.6(a)(10); and

(F) each *generating unit's* or *generating system's*, as applicable, capability to sustain response beyond the timeframe specified in clause 3.3.7.6(c)(1)(E) must be included as part of the relevant *generator performance standard.*

(d) *Negotiation criteria*

(1) A *negotiated generator performance standard* must require that there is no requirement for a *generating system* to operate with an *active power* output:

(A) below its *rated minimum active power* in response to a rise in the *power system frequency* as measured at the *connection point*;

(B) above the relevant maximum *active power* output specified in the *temperature dependency data* provided under clause 3.3.7.2 for the relevant temperature, in response to a fall in the *frequency* of the *power system* as measured at the *connection point*; or

(C) to deliver a rate of change in output exceeding the specified maximum ramp rate.

(2) An additional source of inertia or *frequency* control may be included within the *generating system*. The *control system* for the additional source of inertia or *frequency* control must be coordinated with the remainder of the *generating system* and, together, must meet the performance requirements of the relevant technical requirements.

3.3.7.7 *Frequency* disturbance ride through

(a) *Common requirements*

(1) In relation to the application of this technical requirement, the requirements apply at the *connection point* unless otherwise specified in the relevant clause, or the *Network Service Provider* determines that the technical requirement must be measured at a different location for the particular *generating unit* or *generating system*, in which case the measurement location must be recorded as part of the relevant *generator performance standard*.

(2) Any relevant disconnection settings must be provided as part of the *generator performance standard*.

(3) Where the *Network Service Provider* and *AEMO* have agreed to a protection, or other scheme, that will disconnect the *generating system* or elements of the *generating system*, in order to satisfy the requirements of clause 3.3.7.6, the operation of those schemes based on their agreed parameters will not be taken to be a breach of the requirements of this clause 3.3.7.7.

(4) In relation to the application of this technical requirement, unless otherwise specified in the relevant clause, the requirements apply when operating at any *active power* and *reactive power* level as permitted or required under the other technical requirements in section 3.3.7.

(b) *Ideal generator performance standard*

(1) A *generating system* must maintain *continuous uninterrupted operation* where a *power system* disturbance causes the *frequency* to:

(A) reach 52.5 Hz for a period of up to 6 seconds;

(B) reach 52 Hz for a period of up to 2 minutes;

(C) reach 51.5 Hz for a period of up to 5 minutes;

(D) operate between 49.0 Hz to 51.0 Hz continuously;

(E) reach 47.5 Hz for a period of up to 15 minutes; or

(F) reach 47.0 Hz for a period of up to 2 minutes,

as shown in Figure 3-4.

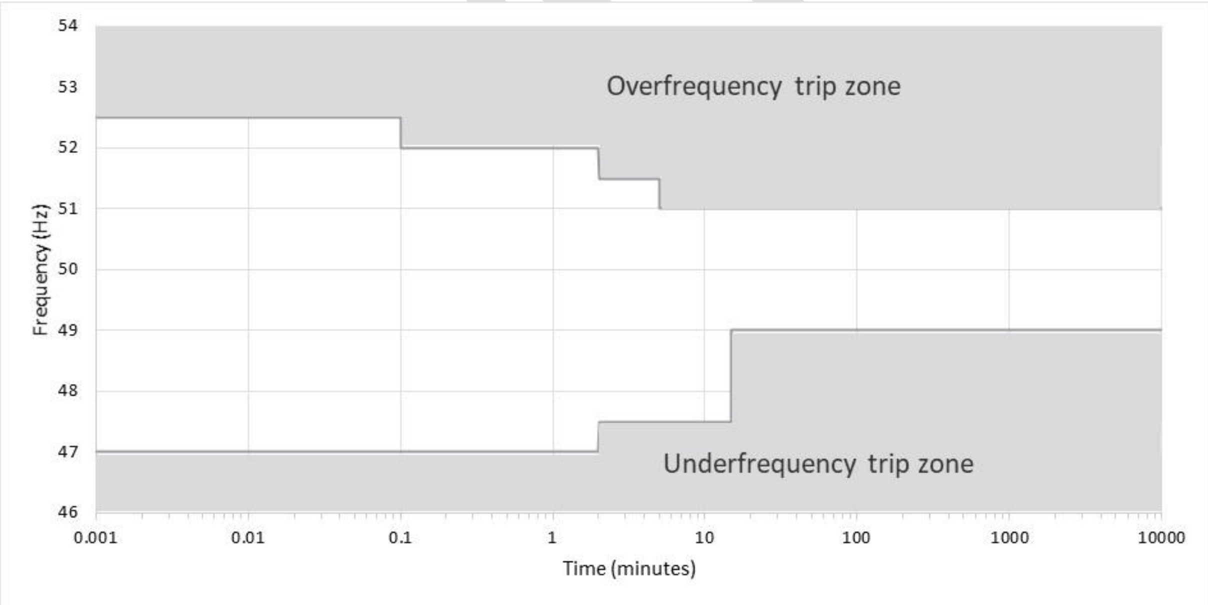

Figure 3-4 *Frequency* variations that a *generating system* must ride through to meet the *ideal generator performance standard*

(2) A *generating system* must maintain *continuous uninterrupted operation* where a *power system* disturbance causes the *RoCoF* to:

(A) reach 4 Hz/s over 250 milliseconds during the disturbance; or

(B) reach 3 Hz/s over one second during the disturbance,

as shown in Figure 3-5.

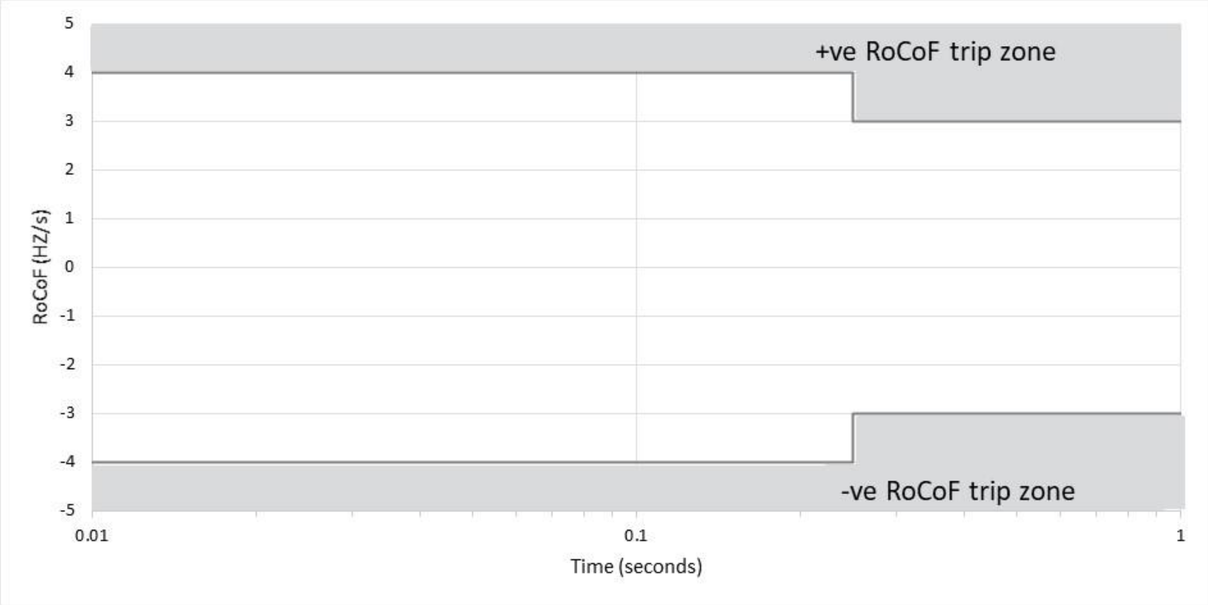

Figure 3-5 *RoCoF* that a *generating system* must ride through to meet the *ideal generator performance standard*

(c) *Minimum generator performance standard*

(1) A *generating system* must maintain *continuous uninterrupted operation* where a *power system* disturbance causes the *frequency* to:

(A) reach 52.0 Hz for a period of up to 2 minutes;

(B) operate between 49.0 Hz to 51.0 Hz continuously;

(C) reach 48.0 Hz for a period of at least 15 minutes;

(D) reach 47.5 Hz for a period of at least 5 minutes; or

(E) reach 47.0 Hz for a period of at least 10 seconds,

as shown in Figure 3-6.

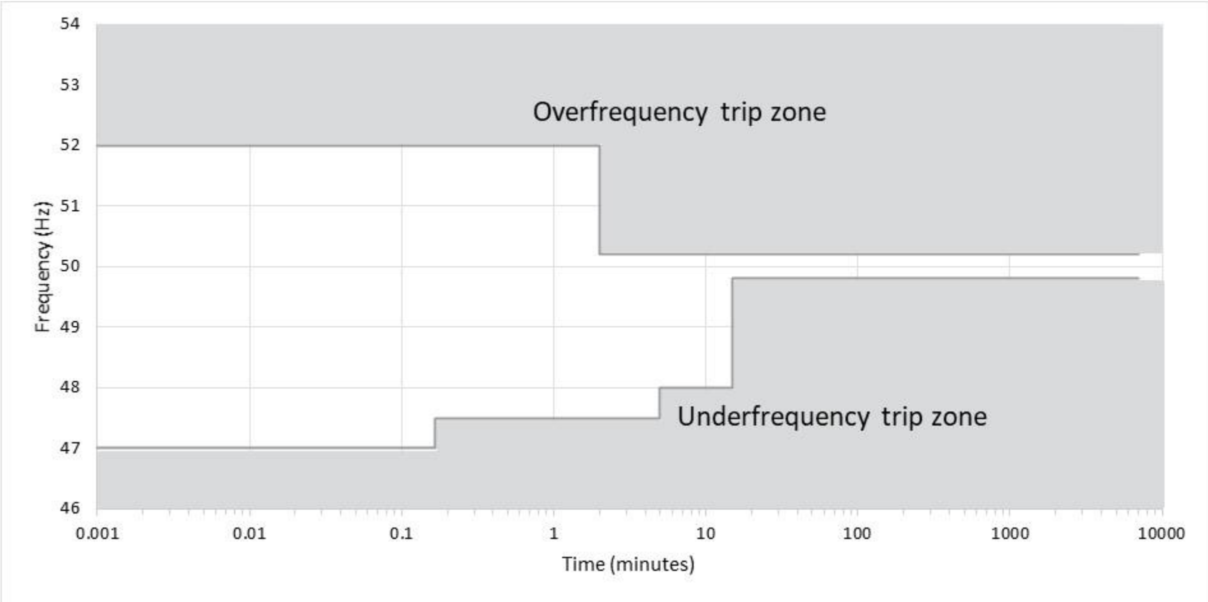

Figure 3-6 *Frequency* variations that a *generating system* must ride through to meet the *minimum generator performance standard*

(2) A *generating system* must maintain *continuous uninterrupted operation* where a *power system* disturbance causes the *RoCoF* to:

(A) reach 2 Hz/s over 250 milliseconds during the disturbance; or

(B) reach 1 Hz/s over one second during the disturbance,

as shown in Figure 3-7.

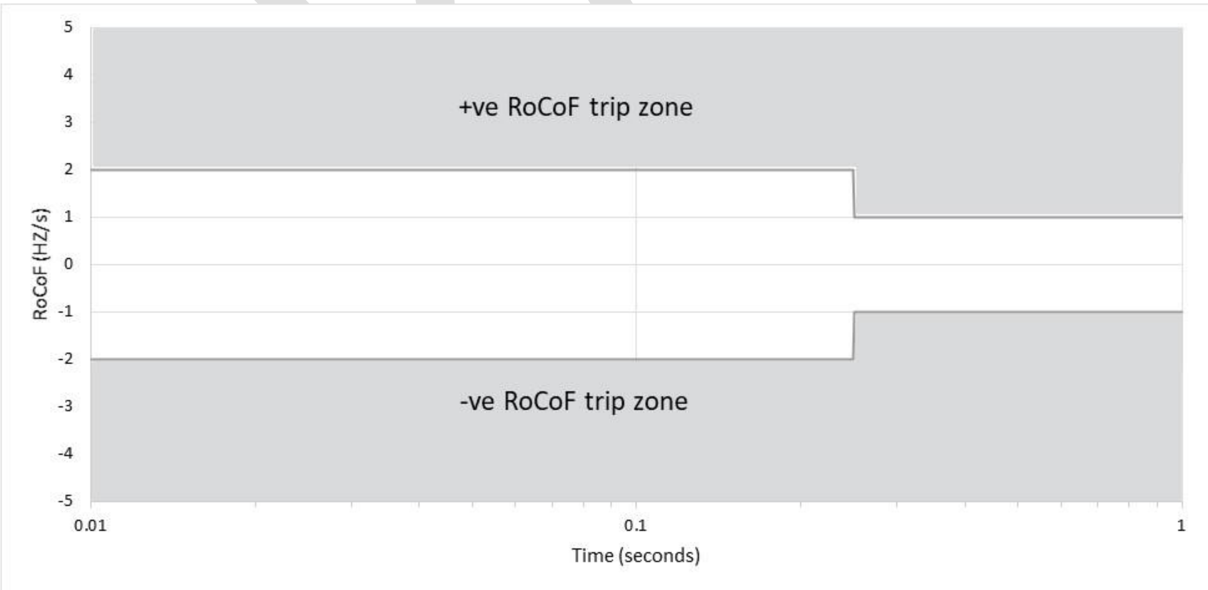

Figure 3-7 *RoCoF* that a *generating system* must ride through to meet the *minimum generator performance standard*

(d) *Negotiation criteria*

(1) A *proposed negotiated generator performance standard* for disturbance ride through for a *frequency* disturbance may be accepted provided the *Network Service Provider* agrees that the *frequency* would be unlikely to fall below the lower bound of the single *contingency event* band specified in the *frequency operating standard*.

3.3.7.8 *Voltage* disturbance ride through

(a) *Common requirements*

(1) In relation to the application of this technical requirement, the requirements apply at the *connection point* unless otherwise specified in the relevant clause, or the *Network Service Provider* determines that the technical requirement must be measured at a different location for the particular *generating unit* or *generating system*, in which case the measurement location must be recorded as part of the relevant *generator performance standard*.

(2) The *generating system* and each of its operating *generating units* is required to remain in *continuous uninterrupted operation* while the *connection point voltage* remains within 90% to 110% of nominal *voltage* for *generating systems connected* to the *transmission system* and 85% to 110% of nominal *voltage* for *generating systems connected* to the *distribution system*.

(3) Any relevant disconnection settings must be provided as part of the *generator performance standard*.

(4) In relation to the application of this technical requirement, unless otherwise specified in the relevant clause, the requirements apply when operating at any *active power* and *reactive power* level as permitted or required under these *Rules*.

(b) *Ideal generator performance standard*

(1) A *generating system* must maintain *continuous uninterrupted operation* where a *power system* disturbance causes the *voltage* to vary within the following ranges:

(A) *voltage* does not exceed 130% of nominal *voltage* for more than 0.02 seconds after T(ov);

(B) *voltage* does not exceed 120% of nominal *voltage* for more than 2.0 seconds after T(ov);

(C) *voltage* does not exceed 115% of nominal *voltage* for more than 20.0 seconds after T(ov);

(D) *voltage* does not exceed 110% of nominal *voltage* for more than 20.0 minutes after T(ov);

(E) *voltage* remains at 0% of nominal *voltage* for no more than 450 milliseconds after T(uv);

(F) *voltage* does not stay below 70% of nominal *voltage* for more than 450 milliseconds after T(uv);

(G) *voltage* does not stay below 80% of nominal *voltage* for more than 2.0 seconds after T(uv); and

(H) *voltage* does not stay below 90% of the nominal *transmission voltage* or 85% of the nominal *distribution voltage* for more than 10.0 seconds after T(uv).

Where:

T(ov) means a point in time when the *voltage* first varied above 110% of nominal *voltage* before returning to between 85% and 110% of nominal *distribution voltage* or between 90% and 110% of nominal *transmission voltage*; and

T(uv) means a point in time when the *voltage* first varied below 90% of nominal *voltage* before returning to between 85% and 110% of nominal *distribution voltage* or between 90% and 110% of nominal *transmission voltage*.

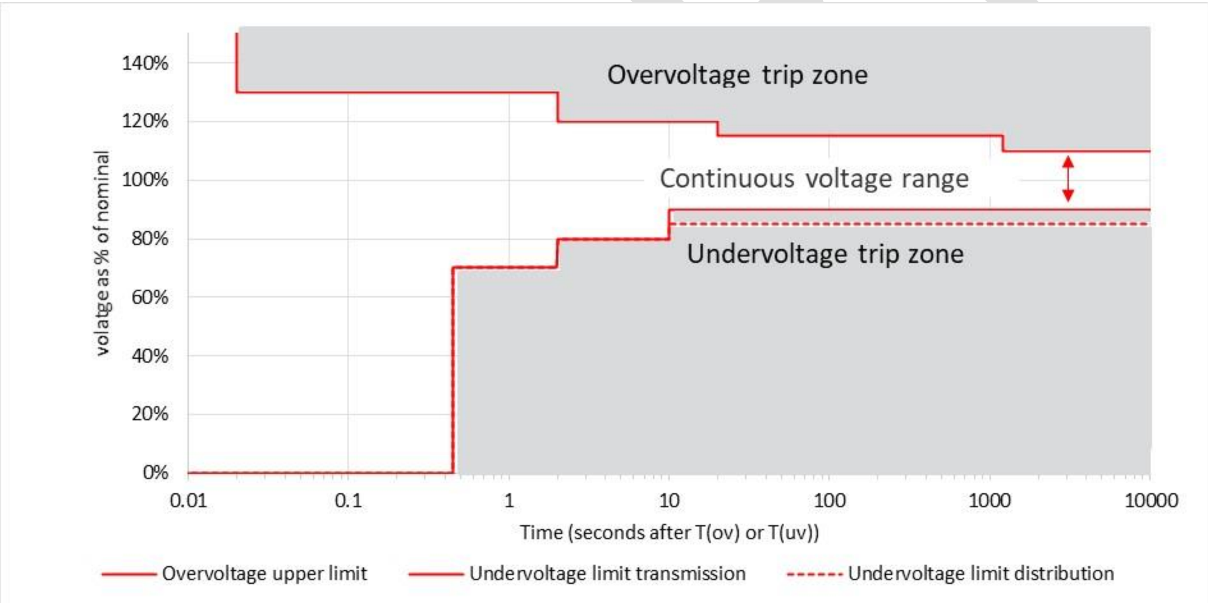

Figure 3-8 *Voltage* variations that a *generating system* must ride through to meet the *ideal generator performance standard*

(c) *Minimum generator performance standard*

(1) A *generating system* must maintain *continuous uninterrupted operation* where a *power system* disturbance causes the *voltage* to vary within the following ranges:

(A) *voltage* does not exceed 120% of nominal *voltage* after T(ov);

(B) *voltage* does not exceed 115% of nominal *voltage* for more than 0.1 seconds after T(ov);

(C) *voltage* does not exceed 110% of nominal *voltage* for more than 0.9 seconds after T(ov);

(D) *voltage* remains at 0% of nominal *voltage* for no more than 450 milliseconds after T(uv) subject to clause 3.3.7.8(c)(2);

(E) *voltage* does not stay below 70% of nominal *voltage* for more than 450 milliseconds after T(uv);

(F) *voltage* does not stay below 80% of nominal *voltage* for more than 2.0 seconds after T(uv); and

(G) *voltage* does not stay below 90% of the nominal *transmission voltage* or 85% of the nominal *distribution voltage* for more than 5.0 seconds after T(uv).

Where:

T(ov) means a point in time when the *voltage* first varied above 110% of nominal *voltage* before returning to between 85% and 110% of nominal *distribution voltage* or between 90% and 110% of nominal *transmission voltage*; and

T(uv) means a point in time when the *voltage* first varied below 90% of nominal *voltage* before returning to between 85% and 110% of nominal *distribution voltage* or between 90% and 110% of nominal *transmission voltage*.

(2) The duration of the zero percent *voltage* level may be relaxed through agreement with the *Network Service Provider*, but shall not be lower than the maximum *total fault clearance time* with no circuit breaker fail as specified in these *Rules*.

(3) Any operational arrangements necessary to ensure the *generating system* and each of its operating *generating units* will meet its *generator performance standard* must be provided as part of the *generator performance standard*.

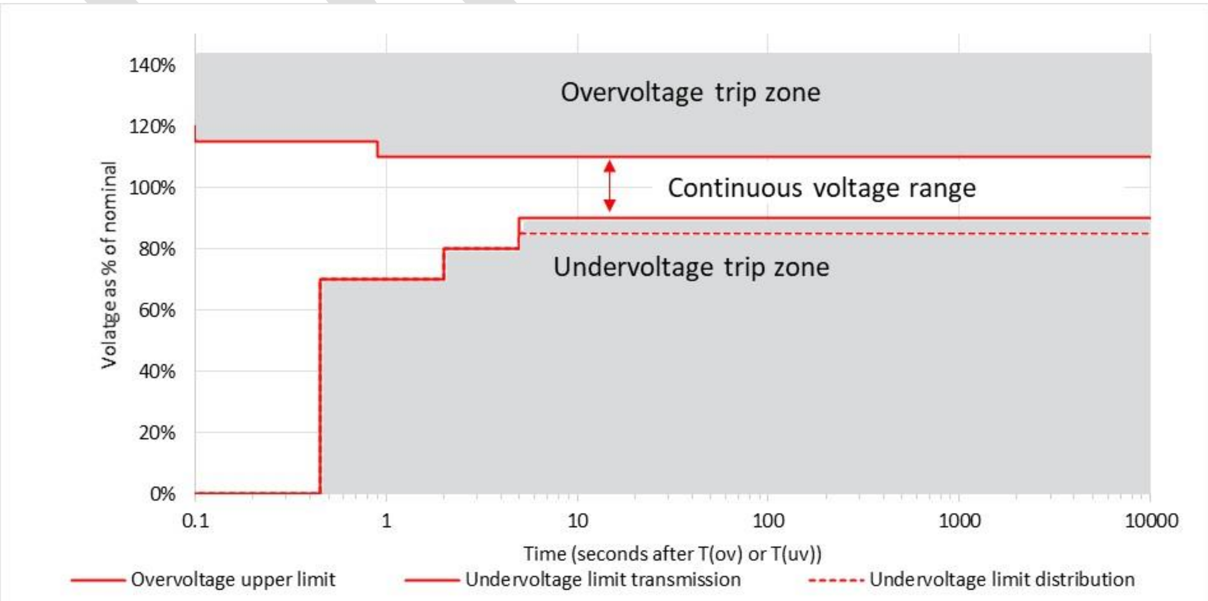

Figure 3-9 *Voltage* variations that a *generating system* must ride through to meet the *minimum generator performance standard*

(d) *Negotiation criteria*

(1) There are no *negotiation criteria* for this technical requirement.

3.3.7.9 Multiple disturbance ride through

Note:
This technical requirement uses the term 'fault' to include a fault of the relevant type having a metallic conducting path.

(a) *Common requirements*

(1) The *common requirements* for disturbance ride through for multiple disturbances as they apply to different *generating systems*, are specified in Table 3-7.

Table 3-7 *Common requirements* for disturbance ride through for multiple disturbances

Type of *generating system*	Relevant requirement
generating system comprised solely of *synchronous generating units*.	Clause 3.3.7.9(a)(2), clause 3.3.7.9(a)(3), clause 3.3.7.9(a)(4), and clause 3.3.7.9(a)(6)
generating system comprised solely of *asynchronous generating units*.	Clause 3.3.7.9(a)(2), clause 3.3.7.9(a)(3) , clause 3.3.7.9(a)(5), and clause 3.3.7.9(a)(6)
generating system comprised of *synchronous generating units* and *asynchronous generating units*.	Clause 3.3.7.9(a)(2), clause 3.3.7.9(a)(3), clause 3.3.7.9(a)(6) and: (a) for that part of the *generating system* comprised of *synchronous generating units*, clause 3.3.7.9(a)(4); (b) for that part of the *generating system* comprised of *asynchronous generating units*, clause 3.3.7.9(a)(5).

(2) Any relevant disconnection settings must be provided as part of the *generator performance standard*.

(3) All *generating systems*

(A) The *generator performance standard* must include any operational arrangements to ensure the *generating system*, including all operating *generating units*, will meet their agreed performance levels under abnormal network or *generating system* conditions.

(B) When assessing multiple disturbances, a fault that is re-established following operation of automatic reclose *protection scheme* shall be counted as a separate disturbance.

(4) *Synchronous generating systems*

(A) For a *generating system* comprised solely of *synchronous generating units*, the reactive current contribution, must equal or exceed 250% of the *maximum continuous current* of the *generating system*. For a *synchronous generating unit* in any other *generating system*, the reactive current contribution must equal or exceed 250% of the *maximum continuous current* of that *synchronous generating unit*.

(5) *Asynchronous generating systems*

(A) For a *generating system* comprised of *asynchronous generating units*:

(i) the reactive current contribution must equal or exceed the *maximum continuous current* of the *generating system*, including all operating *asynchronous generating units*;

(ii) the reactive current contribution and *voltage* deviation may be measured at a location other than the *connection point* (including within the relevant *generating system*) where agreed with the *Network Service Provider*, in which case the reactive current contribution and *voltage* deviation will be assessed at that agreed location;

(iii) the reactive current contribution required may be calculated using phase to phase, phase to ground or sequence components of *voltage*s. The ratio of the negative sequence to positive sequence components of the reactive current contribution must be agreed with the *Network Service Provider* for the types of disturbances specified in this technical requirement; and

(iv) the *generator performance standard* must record all conditions (which may include temperature) considered relevant by the *Network Service Provider* under which the reactive current response is required.

(6) Measurement location and temperature limitations

(A) In relation to the application of this technical requirement, the requirements apply at the *connection point* unless otherwise specified in the relevant clause, or the *Network Service Provider* or *AEMO* determines that the technical requirement must be measured at a different location for the particular *generating unit* or *generating system*, in which case the measurement location must be recorded as part of the relevant *generator performance standard*.

(B) In relation to the application of this technical requirement, unless otherwise specified in the relevant clause, the requirements apply when operating at any *active power* and *reactive power* level as permitted or required under the other technical requirements in these *Rules*, and the *User* responsible for the *generating system* must specify any thermal limitations that may limit the output of the *generating system* or *generating unit* in relation to this technical requirement

(b) *Ideal generator performance standard*

(1) The *ideal generator performance standard* as it applies to different *generating systems*, is specified in Table 3-8:

Table 3-8: Disturbance ride through for multiple disturbances *ideal generator performance standard*

Type of *generating system*	**Relevant requirement**
generating system comprised solely of *synchronous generating units*.	Clause 3.3.7.9(b)(2) and clause 3.3.7.9(b)(3).
generating system comprised solely of *asynchronous generating units*.	Clause 3.3.7.9(b)(2) and clause 3.3.7.9(b)(4).
generating system comprised of *synchronous generating units* and *asynchronous generating units*.	Clause 3.3.7.9(b)(2) and: (a) for that part of the *generating system* comprised of *synchronous generating units*, clause 3.3.7.9(b)(3); (b) for that part of the *generating system* comprised of *asynchronous generating units*, 3.3.7.9(b)(4).

(2) All *generating systems*

(A) A *generating system* and each of its operating *generating units* must remain in *continuous uninterrupted operation* for any disturbances caused by:

(i) a *credible contingency*;

(ii) a three phase fault in a *transmission system* cleared by all relevant primary *protection systems*; and

(iii) a two phase to ground, phase to phase or phase to ground fault in a *transmission or distribution system* or a three phase fault in a *distribution system* cleared in:

- the longest time expected to be taken for a relevant breaker fail *protection system* to clear the fault; or
- if a relevant breaker fail *protection system* is not installed, the greater of 450 milliseconds and the

longest time expected to be taken for all relevant primary *protection systems* to clear the fault,

provided that the event is not one that would *disconnect* the *generating unit* from the *power system* by removing network elements from service or as a result of the operation of an existing inter-trip, *protection scheme* or runback scheme approved by the *Network Service Provider*.

(B) A *generating system* and each of its operating *generating units* must remain in *continuous uninterrupted operation* for a series of up to 15 disturbances within any 5 minute period.

(3) *Synchronous generating systems*

(A) Subject to any changed *power system* conditions or energy source availability beyond the *operator* of the *generating system*'s reasonable control, a *generating system* comprised of *synchronous generating units*, in respect of the faults referred to in clause 3.3.7.9(b)(2)(A), must *supply* to, or absorb from, the network:

(i) to assist the maintenance of *power system voltage*s during the fault, capacitive reactive current of at least the greater of its pre-disturbance reactive current and 4% of the *maximum continuous current* of the *generating system* including all operating *synchronous generating units* (in the absence of a disturbance) for each 1% reduction (from the level existing just prior to the fault) of *connection point voltage* or another agreed location in the *power system* (including within the *generating system*) during the fault;

(ii) after clearance of the fault, *reactive power* sufficient to ensure that the *connection point voltage* or another agreed location in the *power system* (including within the *generating system*) is within the range for *continuous uninterrupted operation*; and

(iii) from 100 milliseconds after clearance of the fault, *active power* of at least 95% of the level existing just prior to the fault.

(4) *Asynchronous generating systems*

(A) Subject to any changed *power system* conditions or energy source availability beyond the *operator* of the *generation system's* reasonable control, a *generating system* comprised of *asynchronous generating units*, for the faults referred to in clause 3.3.7.9(b)(2)(A), must have equipment capable of supplying to, or absorbing from, the network:

(i) to assist the maintenance of *power system voltage*s during the fault:

- capacitive reactive current in addition to its pre-disturbance level of at least 4% of the *maximum* *continuous current* of the *generating system* including all operating *asynchronous generating units* (in the absence of a disturbance) for each 1% reduction of *voltage* at the *connection point* below the under-*voltage* range of 85% to 90% of nominal *voltage*, except where a *generating system* is directly *connected* to the *power system* with no step-up or connection *transformer* and *voltage* at the *connection point* is 5% or lower of nominal *voltage*; and

- inductive reactive current in addition to its pre-disturbance level of at least 6% of the *maximum continuous current* of the *generating system* including all operating *asynchronous generating units* (in the absence of a disturbance) for each 1% increase of *voltage* at the *connection point* the over-*voltage* range of 110% to 115% of nominal *voltage*,

during the disturbance and maintained until *connection point voltage* recovers to between 90% and 110% of nominal *voltage*, or such other range agreed with the *Network Service Provider*; and

(ii) from 100 milliseconds after clearance of the fault, *active power* of at least 95% of the level existing just prior to the fault.

(B) The under-*voltage* and over-*voltage* range referred to in clause 3.3.7.9(b)(4)(A)(i) may be varied with the agreement of the *Network Service Provider* (provided the magnitude of the range between the upper and lower bounds remains at 5%).

(C) The reactive current response referred to in clause 3.3.7.9(b)(4)(A)(i) must have a *rise time* of no greater than 40 milliseconds and a *settling time* of no greater than 70 milliseconds and must be *adequately damped*.

(D) Subject to a *generating system*'s thermal limitations as specified in clause 3.3.7.8(a)(4) and energy source availability, a *generating system* must make available at all times:

(i) sufficient current to maintain rated maintain *rated maximum apparent power* of the *generating system* including all operating *generating units* (in the absence of a disturbance), for all *connection point* voltages above 115% (or otherwise, above the agreed over-voltage range); and

Note:
This clause does not align with the equivalent clause in Appendix 12 of the *WEM Rules* that applies to Transmission Connected Generating Systems. For the *generation* expected to connect under these *Rules*, this drafting is more appropriate.

(ii) the *maximum continuous current* of the *generating system* including all operating *generating units* (in the absence of a disturbance) for all *connection point voltages* below 85% (or otherwise, below the agreed under-*voltage* range),

despite the amount of reactive current injected or absorbed during *voltage* disturbances, except that *AEMO* and the *Network Service Provider* may agree limits on active current injection where required to maintain *power system security* and/or the *quality of supply* to other e*quipment connected* to the *power system*.

(c) *Minimum generator performance standard*

(1) The *minimum generator performance standard* as it applies to different *generating systems*, is specified in Table 3-9.

Table 3-9 Disturbance ride through for multiple disturbances *minimum generator performance standard*

Type of *generating system*	**Relevant requirement**
generating system comprised solely of *synchronous generating units*.	Clause 3.3.7.9(c)(2) and clause 3.3.7.9(c)(3).
generating system comprised solely of *asynchronous generating units*.	Clause 3.3.7.9(c)(2) and clause 3.3.7.9(c)(4).
generating system comprised of *synchronous generating units* and *asynchronous generating units*.	Clause 3.3.7.9(c)(2) and: (a) for that part of the *generating system* comprised of *synchronous generating units*, clause 3.3.7.9(c)(3); (b) for that part of the *generating system* comprised of *asynchronous generating units*, clause 3.3.7.9(c)(4).

(2) All *generating systems*

(A) A *generating system* and each of its operating *generating units* must remain in *continuous uninterrupted operation* for any disturbance caused by:

(i) a *credible contingency*; or

(ii) a single phase to ground, phase to phase or two phase to ground fault or three phase fault in a *transmission or distribution system* cleared in the longest time expected to be taken for all relevant primary *protection systems* to clear the fault,

provided that the event is not one that would *disconnect* the *generating unit* from the *power system* by removing network elements from service or as a result of the operation of an intertrip, *protection scheme* or runback scheme approved by the *Network Service Provider*.

(B) A *generating system* and each of its operating *generating units* must remain in *continuous uninterrupted operation* for a series of up to 6 disturbances within any 5 minute period.

(3) *Synchronous generating systems*

(A) After clearance of a fault, a *generating system* comprised of *synchronous generating units*, in respect of the faults referred to in clause 3.3.7.9(c)(2)(A)must:

(i) deliver *active power* to the network, and *supply* or absorb leading or lagging *reactive power*, sufficient to ensure that the *connection point voltage* or another location in the *power system* (including within the *generating system*), as specified by the *Network Service Provider*, is within the range for *continuous uninterrupted operation* agreed under the relevant *generator performance standard*; and

(ii) return to at least 95% of the pre-fault *active power* output within a period of time agreed by the *Network Service Provider*.

(4) *Asynchronous generating systems*

(A) Subject to a *generating system*'s thermal limitations as specified in clause 3.3.7.8(a)(4)and any changed *power system* conditions or energy source availability beyond the operator of the *generating system*'s reasonable control, a *generating system* comprised of *asynchronous generating units*, for the faults referred to in clause 3.3.7.9(c)(2)(A), must have equipment capable of supplying to, or absorbing from, the network:

(i) to assist the maintenance of *power system voltage*s during the fault:

- capacitive reactive current in addition to its pre-disturbance level of at least 2% of the *maximum continuous current* of the *generating system* including all operating *asynchronous generating units* (in the absence of a disturbance) for each 1% reduction of *voltage* at the *connection point* below a specified threshold level agreed by the *Network Service Provider* within the under-*voltage* range of 80% to 90% of nominal *voltage*, except where:

  - *voltage* at the *connection point* is 15% or lower of nominal *voltage*; or

  - the *generating system* is directly *connected* to the *power system* with no step-up or connection *transformer* and *voltage* at the *connection point* is 20% or lower of nominal *voltage*; and

- inductive reactive current in addition to its pre-disturbance level of at least 2% of the *maximum continuous current* of the *generating system* including all operating *asynchronous generating units* (in the absence of a disturbance) for each 1% increase of *voltage* at the *connection point* above a specified threshold level agreed by the *Network Service Provider* within the over-*voltage* range of 110% to 120% of nominal *voltage*,

during the disturbance and maintained until the *connection point voltage* recovers to between 90% and 110% of nominal *voltage*, or such other range agreed with the *Network Service Provider*; and

(ii) returning to at least 95% of the pre-fault *active power* output, after clearance of the fault, within a period of time agreed by the *Network Service Provider*.

(B) The under-*voltage* and over-*voltage* range referred to in clause 3.3.7.9(c)(4)(A) may be varied with the agreement of the *Network Service Provider* (provided the magnitude of the range between the upper and lower bounds remains at 10%).

(C) Where the *Network Service Provider* require the *generating system* to sustain a response duration of 2 seconds or less, the reactive current response referred to in clause 3.3.7.9(c)(4)(A) must have a *rise time* of no greater than 40.0 milliseconds and a *settling time* of no greater than 70.0 milliseconds and must be *adequately damped*.

(D) Where the *Network Service Provider* requires the *generating system* to sustain a response duration of greater than 2 seconds, the reactive current *rise time* and *settling time* must be as soon as practicable and must be *adequately damped*. The *rise time* and *settling time* must be provided as part of the *generator performance standard*.

(d) *Negotiation criteria*

(1) A *proposed negotiated generator performance standard* may be accepted if the connection of the *generating system* at the proposed performance level would not cause other *generating systems* or *loads* to trip as a result of an event, when they would otherwise not have tripped for the same event.

3.3.7.10 Disturbance ride through for partial *load* rejection

(a) *Common requirements*

(1) In relation to the application of this technical requirement, the requirements apply at the *connection point* unless otherwise specified in the relevant clause, or the *Network Service Provider* determines that the technical requirement must be measured at a different location for the particular *generating unit* or *generating system*, in which case the measurement location must be recorded as part of the relevant *generator performance standard*.

(b) In relation to the application of this technical requirement, unless otherwise specified in the relevant clause, the requirements apply when operating at any *active power* and *reactive power* level as permitted or required under the other technical requirements in these *Rules*, and at all temperatures up to and including the *maximum temperature*.

(c) *Ideal generator performance standard*

(1) A *generating system* and each of its operating *generating units* must be capable of *continuous uninterrupted operation* during and following a sudden reduction in required *active power generation* imposed from the *power system*, provided that the reduction is less than 30% of the *generating system*'s *rated maximum active power* and the required *active power generation* remains above the *generating system*'s *rated minimum active power* output level.

(d) *Minimum generator performance standard*

(1) A *generating system* must be capable of *continuous uninterrupted operation* during and following a sudden reduction in required *active power generation* imposed from the *power system*, provided that the reduction is less than 5% of the *generating system*'s *rated maximum active power* and the required *active power generation* remains above the *generating system*'s *rated minimum active power* output level.

(e) *Negotiation criteria*

(1) There are no *negotiation criteria* for this technical requirement.

3.3.7.11 Disturbance ride through for *quality of supply*

(a) *Common requirements*

(1) There are no *common requirements* for this technical requirement.

(b) *Ideal generator performance standard*

(1) The *ideal generator performance standard* is the same as the *minimum generator performance standard* for disturbance ride through for *quality of supply*.

(c) *Minimum generator performance standard*

(1) A *generating system,* including each of its operating *generating units* and *reactive equipment*, must not *disconnect* from the *power system* as a result of *voltage* fluctuation, harmonic *voltage* distortion and *voltage* unbalance conditions at the *connection point* within the levels specified for flicker, harmonics and negative phase sequence *voltage* in the *Rules*.

(d) *Negotiation criteria*

(1) There are no *negotiation criteria* for this technical requirement.

3.3.7.12 Quality of electricity *generated*

(a) *Common requirements*

(1) A *generating system*, when generating and when not generating, must not produce, at its *connection point* for *generation*, *voltage* imbalance greater than the limits determined by the *Network Service Provider* as necessary to achieve the requirements specified for negative phase sequence *voltage* at the *connection point* in these *Rules*.

(b) *Ideal generator performance standard*

(1) A *generating system*, when generating and when not generating, must not produce at any of its *connection points* for *generation*:

(A) *voltage* fluctuation greater than the limits allocated by the *Network Service Provider* that are no more onerous than the lesser of the acceptance levels determined in accordance with either of the stage 1 or the stage 2 evaluation procedures defined in AS/NZS 61000.3.7 (2001); and

(B) harmonic *voltage* distortion greater than emission limits allocated by the *Network Service Provider* that are no more onerous than the lesser of the acceptance levels determined in accordance with either of the stage 1 or the stage 2 evaluation procedures defined in AS/NZS 61000.3.6 (2001).

(c) Minimum *generator performance standard*

(1) A *generating system*, when generating and when not generating, must not produce at any of its *connection points* for *generation*:

(A) *voltage* fluctuations greater than limits determined by the *Network Service Provider* through the negotiation using the stage 3 evaluation procedure defined in AS/NZS 61000.3.7 (2001), with the *Generator* responsible for the *large generating system* agreeing to fund any works necessary to mitigate adverse effects from accepting this emission level; and

(B) harmonic *voltage* distortion greater than emission limits determined by the *Network Service Provider* through the negotiation using the Stage 3 evaluation procedure defined in AS/NZS 61000.3.6 (2001) with the *Generator* responsible for the *generating system* agreeing to fund any works necessary to mitigate adverse effects from accepting this emission level.

(d) *Negotiation criteria*

(1) A *proposed negotiated generator performance standard* must not prevent the *Network Service Provider* meeting each *SWIS* operating standard or contractual obligations to existing holders of arrangements for *access*.

3.3.8 Remote monitoring requirements

(a) The *Generator* must provide and install *remote monitoring equipment* to enable the *Network Service Provider* or *AEMO* to monitor the performance of a *generating unit* (including its *dynamic performance*) remotely, in real time for control, planning or *power system security*.

(b) All *remote monitoring equipment* installed, upgraded, modified or replaced (as applicable) under clause 3.3.8(a) must conform to the 'Generating System Control and Monitoring Guideline' developed by the *Network Service Provider* in accordance with clause 5.8.1(b) as it applies to *remote monitoring equipment* and be compatible with the *Network Service Provider*'s and *AEMO*'s *SCADA system*, including the requirements of the *nomenclature standards*.

(c) The *remote monitoring equipment* must provide for the signals specified in the 'Generating System Control and Monitoring Guideline' and such other information required by the *Network Service Provider* and *AEMO*.

(d) The *remote monitoring equipment* must be kept available at all times, subject to *outages* as agreed by the *Network Service Provider* and, if applicable, *AEMO*.

3.3.9 Remote control requirements

(a) The *Network Service Provider* or *AEMO* may, for any *generating system* which may be unattended when connected to the *power system*, require *remote control equipment* to be installed in order to enable the *Network Service Provider* or *AEMO* to disconnect a *generating system* from the *power system.*

(b) All *remote control equipment* installed, upgraded, modified or replaced (as applicable) under clause 3.3.9(a) must conform to the 'Generating System Control and Monitoring Guideline' developed by the *Network Service Provider* in accordance with clause 5.8.1(b) of these *Rules* as it applies to *remote control equipment* and be compatible with the *Network Service Provider*'s and *AEMO*'s *SCADA system*, including the requirements of the *nomenclature standards*.

(c) The *remote control equipment* must be kept available at all times, subject to *outages* as agreed by *AEMO* and the *Network Service Provider*.

3.3.10 Communication equipment requirements

(a) A *Generator* responsible for the *large generating system* must provide and maintain communications paths (with redundancy consistent with the 'Generating System Control and Monitoring Guideline') between the *remote monitoring equipment* and *remote communication equipment* installed at any of its *generating units* to a communications interface at the relevant *power station* and in a location acceptable to the *Network Service Provider*. Communications systems between this communications interface and the *Network Service Provider*'s *control centre* are the responsibility of the *Network Service Provider*, unless otherwise agreed.

> **Note:**
>
> For connections to the *distribution system,* the nominated location is in the *zone substation* from which the *distribution feeder* to which the *User* is *connected* emanates.

(b) A *Generator* responsible for the *large generating system* must provide and maintain a primary speech communication channel by means of which routine and emergency control telephone calls may be established between the *operator* of the *generation system* and *AEMO* or the *Network Service Provider*, whichever is applicable.

(c) The primary speech communication channel must meet any requirements specified in the 'Generating System Control and Monitoring Guideline'.

(d) Where the public switched telephone network is to be used as the primary speech communication channel, a sole-purpose connection must be provided, which must be used only for *operational communications*.

(e) The communications paths to any applicable *remote monitoring equipment* or *remote communication equipment* must be kept available at all times, subject to *outages* as agreed by *AEMO*.

(f) The primary speech communication channel must be maintained in good working order.

3.3.11 *Generation* system model

(a) All modelling data described in the WEM Procedure referred to in clause 3A.4.2 of the *WEM Rules* must be provided to the *Network Service Provider* within the timeframes specified in those guidelines, as updated from time to time.

(b) The modelling data provided must be sufficient to enable the *Network Service Provider* or *AEMO* to predict the output of the *generation system* under all *power system* conditions.

(c) The observed performance of the *generating system* must match the predicted performance of the *generating system* using the *generation* system model, as assessed by the *Network Service Provider* or *AEMO*.

(d) The *Generator* must provide updates to the *generation* system model in accordance with the 'Generator and Load Model Guidelines', as updated from time to time.

3.3.12 Safe shutdown without external electricity *supply*

A *generating unit* must be capable of being safely shut down without an electricity *supply* being available from the *transmission or distribution system* at the relevant *connection point*.

3.3.13 Restart following restoration of external electricity *supply*

(a) A *generating unit* must be capable of being restarted and synchronised to the *transmission or distribution system* without unreasonable delay following restoration of external *supply* from the *transmission or distribution system* at the relevant *connection point*, after being without external *supply* for 2 hours or less, provided that the *generating unit* was not *disconnected* due to an internal fault.

Note:
Examples of unreasonable delay in the restart of a *generating unit* are:

- Delays not inherent in the design of the relevant start-up *facilities* and which could reasonably have been eliminated by the relevant *Generator*; and
- The start-up *facilities* for a new *generating unit* not being designed to minimise start up time delays for the *generating unit* following loss of external supplies for 2 hours or less and which could reasonably have been eliminated by the relevant *Generator*.

(b) The maximum restart time, agreed by the *Generator* and the *Network Service Provider*, must be specified in the relevant *connection agreement*.

3.3.14 *Generating unit transformer*

(a) *Transformer* impedance:

The maximum permitted impedance of a *generating unit transformer* is 20% of the *Generator's* MVA rating.

(b) Vector group:

A *generating unit transformer's* vector group must be agreed with the *Network Service Provider.* The vector group must be compatible with the *power system* at the *connection point* and preference may be given to vector groups with a zero sequence opening between *high voltage* and *low voltage* windings.

(c) Tap changing:

A *generating unit transformer* of a *generating unit* or *wind farm* must be capable of on-*load* tap-changing within the range specified in the relevant *connection agreement*.

3.3.15 De-energisation of *Generator* circuits

3.3.15.1 De-energisation of *transmission connected large generating systems*

The *Network Service Provider's* relevant circuit breaker may be used as a point of de-*energisation*, instead of the main switch specified in clause 3.2.2 provided that the *transmission connected Generator* meets the following requirements:

(a) the *Generator* must be able to synchronise any parallel *generating equipment* to the *transmission system* across a circuit breaker owned by the *Generator*;

(b) the *Generator* must be able to clear a fault on its equipment:

(1) without adversely affecting any other *User* or potential *User*; and

(2) within the *fault clearance times* specified in clause 3.5.2(c);

(3) provided that the *substation* where the *Network Service Provider's* relevant circuit breaker is located is in its normal operating configuration.

(c) if:

(1) the *Generator* has only one circuit at the *connection point*; and

(2) the *Network Service Provider's* relevant circuit breaker is located in a meshed *substation*,

and if:

(3) the *Generator's facilities* are continuously manned with personnel capable of resetting a hand-reset *protection* relay; or

(4) the *Generator's facilities* have self-resetting relays,

then the *Generator* may de-energise its equipment by sending a trip signal to the *Network Service Provider's* relevant circuit breaker.

(d) the *Generator* must own a visible point of isolation between the *Network Service Provider's* relevant circuit breaker and the *Generator's* equipment for each piece of equipment *connected* to the *transmission system*.

Note:
Under the relevant *connection agreement,* the *Network Service Provider* will require the *Generator* to indemnify the *Network Service Provider* from any and all liability for any direct or indirect damage caused to its *equipment* or *facility* as a result of the *Generator's* electing to use any *Network Service Provider's* circuit breaker to clear a fault under clause 3.3.15.1(c).

3.3.15.2 Main switch for *distribution connected large generating systems*

(a) Each *facility* at which one or more *generating units* in a *large generating system* is *connected* to the *distribution system* must contain one main switch provided by the *User* for each *connection point* and one main switch for each *generating unit*, where a *generating unit* shares a *connection point* with other *generating units* or *loads*. For larger installations, additional *connection points* and main switches or a dedicated feeder may be required.

(b) Switches must be circuit breakers or automatically operated, fault current breaking and making ganged switches. The relevant *facility* may also contain similarly rated interposed paralleling switches for the purpose of providing alternative synchronised switching operations.

(c) At each relevant *connection point* there must be a means of visible and lockable isolation and test points accessible to the *Network Service Provider's* operational personnel. This may be a withdrawable switch, a switch with visible contacts, a set of removable links or other approved means. The isolation point must be designed to allow the *Network Service Provider's* operational personnel to fit safety locks on the isolation point.

3.3.16 ***Power station* auxiliary *transformers***

In cases where a *power station* takes its auxiliary supplies through a *transformer* by means of a separate *connection point*, the *User* must comply with the conditions for *connection* of *loads* (refer to clause 3.4) in respect of that *connection point*.

3.3.17 **Synchronising**

(a) For a *transmission connected synchronous generating unit* the *Generator* must provide and install automatic synchronising at the *generating unit* circuit breakers.

(b) For a *distribution connected synchronous generating unit* the *Generator* must provide and install automatic synchronising at the *generating unit* circuit breakers.

(c) The *Generator* must provide check synchronising on all *generating unit* circuit breakers and any other circuit breakers, unless interlocked to the satisfaction of the *Network Service Provider,* that are capable of connecting the *User's generating equipment* to the *transmission or distribution system*.

(d) Prior to the initial *synchronisation* of the *generating unit(s)* to the *transmission or distribution system*, the *Generator* and the *Network Service Provider* must agree on written operational procedures for *synchronisation*.

3.3.18 **Secure electricity supplies**

A *Generator* must provide secure electricity supplies of adequate capacity for the operation of equipment performing metering, communication, monitoring, and *protection* functions for at least 8 hours after the loss of AC supplies to that equipment.

3.3.19 **Design requirements for *Generator*'s *substations***

A *Generator* must comply with the requirements of clause 3.4.8.

3.4 REQUIREMENTS FOR CONNECTION OF LOADS

3.4.1 Obligations of *Users*

(a) For the purposes of section 3.4, references to *User* means a *User* that consumes electricity supplied through a *connection point.*

(b) Unless clause 3.4.1(e) applies, for *facilities* associated with the relevant *connection point,* a *User* must comply with the requirements and conditions for *connection* of *loads*:

(1) as set out in this section 3.4; and

(2) in accordance with any relevant *connection agreement* with the *Network Service Provider*.

(c) A *User* must operate its *facilities* and equipment in accordance with any and all *directions* given by *AEMO* or the *Network Service Provider* under these *Rules* or under any *written law*.

(d) A *User* must comply at all times with *protection* requirements specified in clause 3.5.1 and clause 3.5.5.

(e) For *connection points* associated with *electricity storage* or embedded *generation*, the *Network Service Provider* may specify alternative requirements to those outlined in section 3.4 of these *Rules* where the *Network Service Provider* considers meeting the section 3.4 requirements would be inconsistent with achieving the other technical requirements that apply under these *Rules.*

Note: Clause 3.4.1(e) recognises that *electricity storage* and embedded systems need to meet *load* requirements when consuming *active power* at the *connection point* and *generation* requirements when discharging *active power* at the *connection point*. In the event the technical requirements result in conflict (e.g. the *power factor*, *load shedding* facilities), the clause gives the *Network Service Provider* discretion to amend the *load* requirements in section 3.4 of these *Rules* but not the other requirements that apply.

3.4.2 Overview

(a) This clause 3.4 applies to the *connection* of *facilities* and equipment of *Users* to the *transmission and distribution systems*. The specific requirements for the *connection* of a particular *User's facilities* and equipment must be determined by the *Network Service Provider* and will depend on the magnitude and other characteristics of the *User's load*, the *power transfer* capacity, *voltage* and location of the *connection point,* and characteristics of the local *transmission or distribution system* in the vicinity of the *connection point*.

(b) A *User* must provide equipment capabilities, *protection* and *control systems* that ensure that its *load*:

(1) does not cause excessive *load* fluctuations, *reactive power* draw or, where applicable, stalling of motor *loads* that would have an adverse impact on other

Users, *AEMO*, the *Network Service Provider* or the performance of the *power system*; and

(2) does not cause any reduction of inter-*regional* or intra-*regional power transfer capability* based on:

(A) *frequency stability*, or

(B) *voltage stability*,

by more than its *loading* level whenever *connected* relative to the level that would apply if the *User* were *disconnected*.

Note: This requirement is intended to safeguard from transients caused by relatively large *Users* with a high proportion of motor *loads*; for example, to safeguard one mining operation from another.

3.4.3 Power *frequency* variations

A *User* must ensure that the equipment *connected* to its *connection point* is capable of *continuous uninterrupted operation* (other than when the *facility* is faulted) if variations in *supply frequency* of the kind described in clause 2.2.1(a) occur.

3.4.4 Power *frequency voltage* variations

A *User* must ensure that the equipment *connected* to its *connection point* is capable of *continuous uninterrupted operation* (other than when the *facility* is faulted) if variations in *supply voltage* of the kind described in clauses 2.2.2 and 2.2.3 occur.

3.4.5 Provision of information

(a) Before *connection* to the *transmission or distribution system*, a *User* must provide all data relevant to each *connection point* that is required by the *Network Service Provider* in order to complete the detailed design and installation of the relevant *connection assets,* to ensure that there is sufficient *power transfer capability* in the *transmission and distribution systems* to *supply* the *User's load* and that *connection* of the *User's load* will not have an adverse impact on other *Users,* or on the performance of the *power system.*

(b) The specific data that must be provided by a *User* in respect of a particular *connection point* will depend on characteristics of the *User's loads*, the *power transfer* capacity of the *connection point* as specified in the relevant *connection agreement*, the *voltage* and location of the *connection point,* and characteristics of the local *transmission or distribution system* in the vicinity of the *connection point*. Equipment data that may need to be provided includes:

(1) interface *protection* details including line diagram, grading information, secondary injection and trip test certificate on all circuit breakers;

(2) metering system design details for equipment being provided by the *User*;

(3) a general arrangement locating all the major *loads* on the site;

(4) a general arrangement showing all exits and the position of all electrical equipment in *substations* that are directly *connected* to the *connection point*;

(5) type test certificates for new switchgear and *transformers*, including measurement *transformers* to be used for metering purposes;

(6) the proposed methods of earthing cables and other equipment plus a single line earthing diagram;

(7) equipment and earth grid test certificates from approved test authorities;

(8) operational procedures;

(9) details of time-varying, non-sinusoidal and potentially disturbing *loads*;

(10) SCADA arrangements;

(11) *load* details including maximum demand profiles;

(12) a line diagram and service or incoming cable routes and sizes; and

(13) preferred location of the *connection point*.

Note:
Typically, a small domestic *User* will only be required to provide the data referred to in clauses 3.4.5(b)(12) and clause 3.4.5(b)(13).

(c) In addition to the requirements in clause 3.4.5(a) and 3.4.5(b), the *User* must provide *load* data reasonably required by the *Network Service Provider*. Details of the kinds of data that may be required are included in Attachment 3 and Attachment 9.

3.4.6 Design standards

(a) The equipment *connected* to a *User*'s *connection point* must comply with the relevant *Australian Standards* as applicable at the time of first installation of the equipment, the Electricity (Network Safety) Regulations 2015, *good electricity industry practice* and these *Rules* and it must be capable of withstanding the power *frequency voltage*s and impulse levels specified by the *Network Service Provider*.

(b) The circuit breakers, fuses and other equipment provided to isolate a *User*'s *facilities* from the *transmission and distribution system* in the event of a fault must be capable of breaking, without damage or restrike, the fault currents specified by the *Network Service Provider* for the relevant *connection point*.

(c) The equipment ratings *connected* to a *User*'s *connection point* must coordinate with the equipment installed on the *power system*.

3.4.7 *Power factor* requirements

(a) *Power factor* ranges to be met by *loads connected* to the *transmission system* and *loads connected* to the *distribution system* that are rated 1 MVA or more are shown in Table 3-10.

Table 3-10 *Power factor* requirements for *loads*

Permissible Range	
***Supply voltage* (nominal)**	***Power factor* range (half-hour average, unless otherwise specified by the *Network Service Provider*)**
220 kV / 330 kV	0.96 lagging to unity (var absorption)
66 kV / 132 kV	0.95 lagging to unity (var absorption)
<66 kV	0.90 lagging (var absorption) to 0.9 leading (var supply)

(b) The *power factor* range to be met by *loads* of less than 1 MVA *connected* to the *distribution system* is 0.8 lagging to 0.8 leading. Where necessary to ensure the satisfactory operation of the *distribution system*, a different *power factor* range may be specified in the relevant *connection agreement*.

(c) The *Network Service Provider* after consulting with *AEMO* may permit a lower lagging or leading *power factor* where this will not reduce *power system security*, *quality of supply* or require a higher lagging or leading *power factor* to achieve the *power transfer*s required by the *load.*

(d) A *shunt capacitor* installed to comply with *power factor* requirements must comply with the *Network Service Provider's* requirements to ensure that the design does not severely attenuate audio *frequency* signals used for *load* control or operations.

(e) A *static var compensator* system installed for either *power factor* or *quality of supply* requirements must have a *control system* that does not interfere with other control functions on the *transmission and distribution system*. Adequate filtering *facilities* must be provided if necessary to absorb any excessive harmonic currents.

3.4.8 Design requirements for *Users*' *substations*

Equipment in or for any *User's substation* that is *connected* directly to a *connection point* must comply with the following requirements:

(a) safety provisions that comply with the requirements of the *Network Service Provider* must be incorporated into the *substation facilities*;

(b) where required by the *Network Service Provider*, interfaces and accommodation must be provided by the *User* for metering, communication, remote monitoring and *protection* equipment to be installed in the *substation* by the *Network Service Provider*;

(c) the *substation* must be capable of continuous uninterrupted operation within the system performance standards specified in Chapter 2;

(d) the *transformer* vector group must be agreed with the *Network Service Provider.* The vector group must be compatible with the *power system* at the *connection point* and preference given to vector groups with a zero sequence opening between *high voltage* and *low voltage* windings;

(e) earthing of *primary equipment* in the *substation* must be in accordance with the *WA Electrical Requirements* and AS/NZS 2067 for *high voltage equipment* or *AS/NZS* 3000 for *low voltage equipment*. The earthing system must satisfy these requirements without any reliance on the *Network Service Provider's* equipment. Where it is not possible to design a compliant earthing system within the boundaries of a *User's* plant, the *Network Service Provider* must provide a *User* access to its easement for the installation of earthing conductors and stakes where it is practical to do so and provided that this is not precluded by any legal requirement;

(f) *synchronisation facilities* or reclose blocking must be provided if *generating units* are *connected* through the *substation*; and

(g) insulation levels of equipment in the *substation* must coordinate with the insulation levels of the *transmission and distribution system* to which the *substation* is *connected* without degrading the design performance of the *transmission and distribution system*.

3.4.9 *Load shedding* facilities

3.4.9.1 General

(a) *User*s must provide automatic *load shedding* facilities where required by the *Network Service Provider* in accordance with clause 2.4(b).

(b) *Load shedding* facilities provided by a *User* that respond to under *frequency* events must be designed to achieve a reduction in *active power* import at the *connection point.*

(c) Where *load shedding* facilities provided by a *User* that respond to under *frequency* events includes *generation* the *User* must remain compliant with any applicable export limits.

> **Note:**
> Consistent with the definition for *electricity storage* provided in the Attachment 1 of these *Rules*, *generation* in this clause refers to both *generation* from a *generating unit* and *electricity storage* when discharging *active power*.

3.4.9.2 Installation and testing of *load shedding* facilities

A *User* that controls a *load* subject to *load shedding* in accordance with clause 2.4(b) must:

(a) provide, install, operate and maintain equipment for *load shedding*;

(b) co-operate with the *Network Service Provider* in conducting periodic functional testing of the *load shedding* equipment, which must not require *load* to be *disconnected*;

(c) apply under*frequency* settings to relays as determined by the *Network Service Provider*; and

(d) apply under*voltage* settings to relays as determined by the *Network Service Provider*.

3.4.10 Monitoring and control requirements

3.4.10.1 Remote monitoring

(a) The *Network Service Provider* may require large *transmission and distribution system connected Users* to:

(1) provide *remote monitoring equipment* (*RME*) to enable *AEMO* or the *Network Service Provider* to monitor the status and indications of the *load* remotely where this is necessary in real time for management, control, planning or *power system security*; and

(2) upgrade, modify or replace any *RME* already installed in a *User's substation* where the existing *RME* is, in the opinion of the *Network Service Provider*, no longer fit for purpose and notice is given in writing to the relevant *User*.

(b) An *RME* provided, upgraded, modified or replaced (as applicable) in accordance with clause 3.4.10.1(a) must:

(1) be compatible with the *Network Service Provider's SCADA system*, including *nomenclature standards*; and

(2) conform with at least the minimum standard agreed by the *Network Service Provider.*

(c) Input information to *RME* may include the following:

(1) status indications

(A) relevant circuit breakers open/closed (dual point) within the equipment;

(B) relevant isolators within the equipment;

(C) connection to the *transmission or distribution system*; and

(D) relevant earth switches;

(2) alarms

(A) *protection* operation;

(B) *protection* fail;

(C) battery fail - AC and DC;

(D) *trip circuit supervision*; and

(E) *trip supply supervision*;

(3) measured values

(A) *active power load*;

(B) *reactive power load*;

(C) *load* current; and

(D) relevant *voltages* throughout the equipment, including *voltage* on the *Network Service Provider* side of main switch.

3.4.10.2 *Network Service Provider's* communications equipment

Where *remote monitoring equipment* is installed in accordance with clause 3.4.10.1, the *User* must provide communications paths (with appropriate redundancy) between the *remote monitoring equipment* and a communications interface in a location reasonably acceptable to the *Network*

Service Provider. Communications systems between this communications interface and the relevant *control centre* are the responsibility of the *Network Service Provider* unless otherwise agreed.

3.4.11 Secure electricity supplies

All *Users* must provide secure electricity supplies of adequate capacity for the operation of equipment performing metering, communication, monitoring, and *protection* functions for at least 8 hours after the loss of AC supplies to that equipment.

3.5 USER'S PROTECTION REQUIREMENTS

3.5.1 Overview

(a) The requirements of this clause 3.5 apply only to a *User's protection system* that is necessary to maintain *power system security.* The extent of a *User's* equipment that conform to the requirements of this clause 3.5 will vary from installation to installation dependent on the specific requirements in clause 3.5. Consequently, each installation should be assessed individually by the *Network Service Provider*. Information that may be required by the *Network Service Provider* to complete this assessment is specified in Attachment 5. *Protection systems* installed solely to cover risks associated with a *User's* equipment are at the *User's* discretion.

(b) The requirement for *protection systems* in respect of any *User's* equipment that forms an integral part of the *transmission or distribution system* (as seen from the *transmission or distribution system*) is the same as would apply under clause 2.9 if that equipment were the *Network Service Provider's* equipment. For the purposes of this clause 3.5.1(b) a *User's* equipment forms an integral part of the *transmission and distribution system* when the *connection asset* (such as a circuit breaker) that is used to *disconnect* a *User's* equipment from the *transmission or distribution system* is owned by a *User*.

(c) All *User's* equipment *connected* to the *transmission or distribution system* must be protected by *protection systems* or devices that automatically *disconnect* any faulty circuit from the *transmission or distribution system*.

(d) A *User* and the *Network Service Provider* must cooperate in the design and implementation of *protection systems*, including with regard to:

(1) the functionality of any *protection system* required as a condition of the *User's* connection to the *transmission or distribution system*;

(2) the use of *current transformer* and *voltage transformer* secondary circuits (or equivalent) of one party by the *protection system* of the other;

(3) tripping of one party's circuit breakers by a *protection system* of the other party; and

(4) co-ordination of *protection system* settings to ensure inter-operation.

> **Note:**
> Any reliance on the *Network Service Provider's protection system* to protect an item of *User's* equipment, and vice versa, including the use of *current transformers and voltage transformers* (or equivalent) and the tripping of circuit breakers, must be included in the relevant *connection agreement*.

(e) A *User's protection systems* must be located on the relevant *User's* equipment and must discriminate between the *Network Service Provider's protection systems* and that of other *Users*.

(f) Except in an emergency, a *User* with equipment *connected* directly to the *transmission system* must notify the *Network Service Provider* at least 5 *business days* prior to taking out of service all or part of a *protection system* of any equipment operating at a nominal *voltage* of 66 kV or greater.

(g) The installation and use of *automatic reclose equipment* in a *User's facility* is permitted only with the prior written agreement of the *Network Service Provider*.

(h) A *User* must not adjust their *protection* settings or otherwise modify its *protection systems*, including replacing associated *primary* or *secondary equipment*, without the *Network Service Provider's* approval.

3.5.2 *Protection* requirements for *transmission* connected *generating systems*

(a) Subject to clause 3.5.2(b), a *Generator* responsible for a *generating system connected* to the *transmission system* must satisfy the *protection* requirements specified in this clause 3.5.2.

(b) A *Generator,* responsible for a *generating system* that has an aggregate rated capacity of less than or equal to 1 MVA, is comprised solely of *inverter connected generating units*, and is *connected* to the *transmission system* must satisfy the *protection* requirements specified in this clause 3.5.3.

(c) The *main protection system* for a *generating unit* must incorporate *two fully independent protection schemes*, each discriminating with the *transmission system*. Where a *critical fault clearance time* exists, each *protection scheme* must be capable of operating to achieve the *critical fault clearance time*. Where there is no *critical fault clearance time* both independent *protection schemes* must meet the relevant maximum *total fault clearance times* specified in clause 2.9.4.

(d) The design of the *two fully independent protection schemes* must make it possible to test and maintain either *protection scheme* without interfering with the other.

(e) The *Generator's protection system* and other controls must achieve the following functions:

(1) disconnection of the *Generator's generation* from the *transmission systems* if any of the *protection schemes* required by clause 3.5.2(c) operate;

(2) anti-islanding *protection* to ensure the *generating system* is prevented from supplying an isolated portion of the *power system* when it is not secure to do so consistent with the guideline developed by the *Network Service Provider* in accordance with clause 3.5.2(g) with that *protection* only enabled by the *Generator* when *AEMO* or the *Network Service Provider* instructs*;*

(3) prevention of the *Generator's generating unit* from energising de-energised *Network Service Provider* equipment, or energising and supplying an otherwise isolated portion of the *transmission system* except where a *Generator* is contracted under the *WEM Rules* to provide a black start service and is directed to provide this service by *AEMO*;

(4) adequate *protection* of the *Generator's* equipment without reliance on back up from the *Network Service Provider's protection apparatus* except as agreed with the *Network Service Provider* in accordance with clause 3.3.15 or 3.5.1(d);

(5) detection of a failure of a *Generator's* circuit breaker to clear a fault due to either mechanical or electrical failure. If such a failure is detected, the *Generator protection system* must send a trip signal to an alternative circuit breaker, which may be provided by the *Network Service Provider* in accordance with clause 3.5.1(d), in order to clear the fault; and

(6) disconnection of the *generating system* during abnormal conditions in the *power system* that would threaten the stability of the *generating system*, or risk damage to the *generating system*. The settings of these *protection schemes* must deliver the required performance for disturbance ride through specified in clause 3.3.7.7, clause 3.3.7.8 and clause 3.3.7.9.

(f) A *Generator* must install check synchronising interlocks on all of their circuit breakers that are capable of out-of-*synchronism* closure, unless otherwise interlocked to the satisfaction of the *Network Service Provider*.

(g) The *Network Service Provider* must develop a guideline detailing the performance requirements for anti-islanding systems for *large generating systems connected* to the *transmission system*.

3.5.3 *Protection* requirements for *distribution connected generating systems*

3.5.3.1 Application

(a) A *Generator* responsible for a *generating system connected* to the *distribution system* other than via a *standard connection service*, must satisfy the *protection* requirements specified in this clause 3.5.3.

(b) The *protection* requirements for a *generating system connected* to the *low voltage distribution system* via a *standard connection service* are specified in clause 3.5.4.

3.5.3.2 General

(a) Subject to clause 3.5.3.2(b), a *Generator* must provide, as a minimum, the *protection* functions specified in this clause 3.5.3.2. *Protection* functions should respond to quantities measured at the *connection point*.

(b) For a *generating system* with an aggregate rated capacity less than or equal to 1 MVA and comprised of *inverter connected generating units,* the *Network Service Provider* may accept *protection* functions that respond to quantities measured at other locations within the *User's facility* provided these *protection* arrangements:

(1) are consistent with any guidelines developed by the *Network Service Provider*; and

(2) do not reduce the ability to maintain *power system security*.

(c) A *Generator's* proposed *protection system* and settings must be approved by the *Network Service Provider*, who must assess their likely effect on the *distribution system* and may specify modified or additional requirements to ensure that the performance standards specified in clause 2.2 are met, the *power transfer capability* of the *distribution system* is not reduced and the *quality of supply* to other *Users* is maintained. Information that may be required by the *Network Service Provider* prior to giving approval is specified in Attachment 5 and Attachment 10.

(d) A *Generator's protection system* must clear internal plant faults and coordinate with the *Network Service Provider's protection system*.

(e) The design of a *Generator's protection system* must ensure that failure of any *protection* device cannot result in the *distribution system* being placed in an unsafe operating mode or lead to a disturbance or safety risk to the *Network Service Provider* or to other *Users*.

> **Note:**
> This may be achieved by providing back-up *protection schemes* (including *protection* functions implemented in AS/NZS 4777.2 compliant *inverters*) or designing the *protection system* to be fail-safe e.g., to trip on failure.

(f) All dedicated *protection apparatus* must comply with the IEC 60255 series of standards. Integrated control and *protection apparatus* may be used provided that it can be demonstrated that the *protection* functions are functionally independent of the control functions, i.e. failure or mal-operation of the control features will not impair operation of the *protection system*.

(g) All *power stations* must provide under and over *voltage*, under and over *frequency* and overcurrent *protection schemes* in accordance with the equipment rating.

(h) All *power stations* must provide earth fault *protection* for earth faults on the *distribution system*.

> **Note:**
> The earth fault *protection scheme* may be earth fault or neutral *voltage* displacement (depending on the earthing system arrangement). For *generating systems* with an aggregate rated capacity of less than or equal to 1 MVA and *connected* via *inverters*, the earth fault *protection* may be integrated within an anti-islanding scheme.

(i) All *power stations* must provide *protection* against abnormal *distribution system* conditions that would threaten the stability of the *generating system*, or risk damage to the *generating system*. The settings of these *protection schemes* must deliver the required performance for disturbance ride through specified in clauses 3.3.7.7, 3.3.7.8 and 3.3.7.9.

(j) All *power stations* that have an export limit shall have directional (export) power or directional current limits set appropriate to the export limit. For *inverter* connected *generators* that conform with AS/NZS 4777.2, in certain circumstances, the export limit control set to the appropriate export limit may be used in place of an external protection relay. The *Network Service Provider* must advise the *Generator* of the conditions to be satisfied for the *Network Service Provider* to accept the export limit control in the *inverters*.

(k) All *power stations* must have loss of AC and DC auxiliary *supply protection*, which must immediately trip all switches that depend on that *supply* for operation of their *protection*, except where the auxiliary *supply* is duplicated in which case the failure may be alarmed in accordance with clause 3.5.3.6.

(l) Where *synchronisation* is time limited, the *power station* must be dis*connected* by an independent timer.

(m) *Generating units* that are only operated in parallel with the *distribution system* during *rapid bumpless transfer* must be protected by an independent timer that will *disconnect* the *generating unit* from the *distribution system* if the bumpless transfer is not successfully completed. Automatic transfer switches must comply with AS 60947.6.2 (2004). For the avoidance of doubt *generating units* that are only operated in parallel with the *distribution system* during *rapid bumpless transfer* need not comply with subclauses (g) to (l) of this clause 3.5.3.2.

> **Note:**
> The above exemption from subclauses (g) to (l) of clause 3.5.3.2 recognises that the *rapid bumpless transfer* will be completed or the *generating unit* will be dis*connected* by the disconnection timer before other *protection schemes* operate. *Protection* of the *generating unit* when it is not operating in parallel with the *distribution system* is at the discretion of the *Generator*.

3.5.3.3 Pole slipping

Where it is determined that the disturbance resulting from loss of *synchronism* is likely to exceed that permitted in clause 2.2, the *Generator* must install a pole slipping *protection scheme*.

3.5.3.4 Islanding *protection*

(a) A *power station* must not *supply* power into any part of the *distribution system* that is dis*connected* from the *power system*.

> **Note:**
> This *protection* against loss of external *supply* (loss of mains) may be *rate of change of frequency* (*RoCoF*), *voltage* vector shift, directional (export) power or directional over current or any other method, approved by the *Network Service Provider*, that can detect a balanced *load* condition in an islanded state.

(b) For parallel operation (which excludes *rapid* or *gradual bumpless transfer)* under all operating modes, islanding *protection schemes* of two different functional types must be provided to prevent a *generating unit* energising a part of the *distribution system* that has become isolated from the remainder of the *transmission or distribution system*.

(c) A *Generator* responsible for a *small generating system* with an aggregate rated capacity of less than or equal to 1 MVA and *inverter connected*, may propose meeting requirements specified in clause 3.5.3.4(b) through the combination of one IEC 60255 compliant external *Generator protection* relay and *protection* functions implemented in AS/NZS 4777.2 compliant *inverters* that connect the *generating system*. The *Network Service Provider* may accept such arrangements as satisfying the requirements of clause 3.5.3.4(b) provided it is satisfied that the proposed arrangements are sufficient to maintain *power system security.*

(d) For *generating systems* that have an aggregate rated capacity of less than or equal to 1 MVA and *connected* to the *low voltage distribution system* via *inverters*, the *Network Service Provider* may accept that the islanding *protection* incorporated within *inverters* provides sufficient islanding *protection* to ensure that the *small generating system* will not *supply* power into any part of the *distribution system* that is dis*connected* from the *power system*. The *Network Service Provider* must advise the *Generator* of the conditions that need to be satisfied for the *Network Service Provider* to accept the islanding *protection* incorporated in the *inverters* is acceptable. If the *Network Service Provider* is not satisfied that the required conditions have been met, the *Generator* must install islanding *protection* meeting the requirement specified in clause 3.5.3.4(c).

(e) For *power stations* rated above 1 MVA, there must not be a common failure mode between each functional type of islanding *protection scheme*. This requirement may be applied to *power stations* rated below 1 MVA in situations where it is possible for the *power station* to support a sustained island on a part of the *high voltage distribution system*.

> **Note:**
> For clarity, functional types of islanding *protection* may share the same *voltage* and current *transformers* but must be *connected* to different secondary windings.

(f) Where there is no export of *power* into the *distribution system* and the aggregate rating of the *power station* is less than 150 kVA, islanding *protection schemes* can be in the form of a directional *power* function that will operate for *power* export. Directional overcurrent relays may also be used for this purpose.

(g) *Generating units* designed for *gradual bumpless transfer* must be protected with at least one functional type of loss of mains *protection scheme*.

(h) Islanding *protection* must operate within 2 seconds to ensure disconnection before the first *distribution system* reclosing attempt (typically 5 seconds). Relay settings are to be agreed with the *Network Service Provider*.

> **Note:**
> It should be assumed that the *Network Service Provider* will always attempt to auto-reclose to restore *supply* following transient faults.

3.5.3.5 Intertripping

In cases where, in the opinion of the *Network Service Provider*, the risk of undetected islanding of part of the *distribution system* and the *Generator's facility* remains significant, the *Network Service Provider* may also require the installation of an intertripping link between the *Generator's* main switch(es) and the feeder circuit breaker(s) in the *zone substation* or other upstream *protection* device nominated by the *Network Service Provider*.

3.5.3.6 Failure of *generator*'s *protection* equipment

Any failure of the *Generator*'s *protection apparatus* must automatically trip the *generating unit's* main switch except, where the affected *protection apparatus* forms part of a *protection system* comprised of *two fully independent protection schemes*, the failure may instead be alarmed within the *Generator*'s *facility* provided that operating procedures are in place to ensure that prompt action is taken to remedy such failures.

3.5.4 *Protection* requirements for *small generating systems connected* via a *standard connection service*

(a) The *protection* requirements specified in this clause 3.5.4, must be satisfied by *Generators* responsible for *small generating systems connected* to the *low voltage distribution system* via a *standard connection service*.

(b) An *inverter energy* system *connected* to the *distribution system* must be approved by the *Network Service Provider* and the *User* must meet the following requirements:

(1) the *User* must provide the information required by the *Network Service Provider* prior to approval being given;

(2) the *User* must maintain the integrity of the *protection* and *control systems* of the *inverter energy* system so that they comply with the requirements of these *Rules*, *AS*/NZS 4777 series and the *connection agreement* at all times;

(3) the *User* must configure *inverter* control and *protection* settings as specified in the *connection agreement*; and

(4) the *User* must provide evidence to demonstrate to the satisfaction of the *Network Service Provider* that the setting specified in the *connection agreement* have been implemented.

3.5.5 *Protection* requirements for *loads*

(a) A *User* must provide a *main protection system* to *disconnect* from the *power system* any faulted element within its *protection* zone within the maximum *total fault clearance time* agreed with the *Network Service Provider* and specified in the relevant *connection agreement*. For equipment supplied from *connection points* with a nominal *voltage* of 33 kV or greater, the maximum *total fault clearance times* are the relevant times specified in clause 2.9.4 unless a *critical fault clearance time* applies in accordance with clause 2.9.5, in which case the required maximum *total fault clearance time* is the *critical fault clearance* time.

(b) If the *User's connection point* has a nominal *voltage* of 66 kV or greater, the *main protection system* must:

(1) have sufficient redundancy to ensure that a faulted element is *disconnected* from the *power system* within the applicable *fault clearance time* as determined in accordance with clause 3.5.5(a) with any single *protection* element (including any communications *facility* upon which the *protection system* depends) out of service;

(2) provide a *circuit breaker failure protection scheme* to clear faults that are not cleared by the circuit breakers controlled by the primary *protection system* within the applicable *fault clearance time* as determined in accordance with clause 3.5.5(a). If a circuit breaker fails, the *User's protection system* may send a trip signal to a circuit breaker provided by the *Network Service Provider* in accordance with clause 3.5.1(d), in order to clear the fault.

(c) A *User* whose *facilities* are *connected* to the *high voltage distribution system* may be required to provide a sensitive earth fault *protection scheme* that complies with the IEC 60255 series of standards.

3.6 REQUIREMENTS FOR CONNECTION OF SMALL GENERATING SYSTEMS TO THE TRANSMISSION OR HIGH *VOLTAGE* DISTRIBUTION SYSTEM

3.6.1 Overview

(a) This clause 3.6 addresses the requirements for the connection of *small generating systems* (i.e., *generating systems* of aggregate rated capacity less than or equal to 5 MVA)to the *transmission system* or the *high voltage distribution system*. This does not apply to the connection of *small generating systems* to the *low voltage distribution system* (in which case either clause 3.7 or 3.8 applies).

(b) A *Generator* responsible for a *small generating system connected to the transmission system* must comply at all times with *protection* requirements specified in clauses 3.5.1 and 3.5.2.

(c) A *Generator* responsible for a *small generating system connected to the high voltage distribution system* must comply at all times with *protection* requirements specified in clauses 3.5.1 and 3.5.3.

3.6.2 Categorisation of *facilities*

(a) This clause 3.6 covers *generating units* of all types, whether using renewable or non-renewable *energy* sources.

(b) Unless otherwise specified, technical requirements for *generating units* shall apply at the *connection point*, rather than at the *generating unit* terminals.

(c) In this clause 3.6, *connection points* for *small generating systems* are characterised as:

(1) *transmission connected:* 3 phase, 66 kV, 132 kV, 220 kV or 330 kV; or

(2) *high voltage distribution connected*: 3 phase, 6.6 kV, 11 kV, 22 kV or 33 kV.

3.6.3 Information to be provided by the *Generator*

(a) A *Generator* must provide to the *Network Service Provider* information in relation to the design, construction, operation and configuration of the *small generating system* as is reasonably required to ensure that the operation and performance standards of the *power system,* or other *Users,* are not adversely affected by the operation of the *small generating system*. Details of the kinds of information that may be required are included in Attachment 10. Where considered necessary by the *Network Service Provider* additional information of the kind included in Attachment 3 may be required and shall be provided by the *Generator*.

(b) In order to allow the *Network Service Provider* to assess the impact of the *generating system* on the operation and performance of the *power system* or on other *Users,* a *Generator* must provide data on:

(1) *power station* and *generating unit* aggregate *active power* and *reactive power*;

(2) flicker coefficients and harmonic profile of the equipment. Data on power quality characteristics, including flicker and harmonics, in accordance with IEC 61400-21 must be provided for all wind turbines. Similar data may also be required for other *inverter connected generating systems* such as solar farms;

(3) Net import / export data must be provided in the form of:

(A) a typical 24 hour power curve measured at 15 minute intervals (or better if available); and

(B) details of the maximum kVA output over a 60 second interval,

or such other form as specified in the relevant *connection agreement*.

(4) When requested by the *Network Service Provider*, a *Generator* must provide details of the proposed operation of the equipment during start-up, shut-down, normal daily operation, intermittent fuel or wind variations and under fault or *emergency conditions*.

3.6.4 Safety and contribution to *power system reliability*

(a) The requirements imposed on a *Generator* by this clause 3.6 are intended to provide minimum safety and reliability standards to protect the *power system* and other *User's* equipment. Safety, *power system reliability* and the *quality of supply* to other *Users* are paramount and *access application*s must be evaluated accordingly.

(b) A *Generator* shall not cause the *power system* performance to degrade below minimum safety and reliability standards for the *power system* or below minimum requirements that affect the *quality of supply* for other *Users*. In addition to meeting clause 3.6, the *Generator* must design and operate its *facilities* in accordance with applicable standards and regulations, *good electricity industry practice* and the manufacturers' recommendations.

(c) Where it is apparent that the operation of equipment installed in accordance with the requirements of this clause 3.6 may nevertheless have an adverse impact on the operation, safety or performance of the *power system*, or on the *quality of supply* to other *Users*, the *Network Service Provider* must consult with the *Generator* to reach an agreement on an acceptable solution. As a consequence, the *Network Service Provider* may require the *Generator* to test or modify its relevant equipment.

(d) Unless otherwise agreed in the relevant *connection agreement*, the *Network Service Provider* may require a *Generator* not to operate equipment in abnormal *power system* operating conditions.

3.6.5 Technical requirements

(a) All *small generating systems* with aggregate rated capacity greater than 150 kVA must achieve the *common requirements* and *minimum generator performance standards* specified in the following clauses:

(1) 3.3.7.3 - *reactive power* capability

(2) 3.3.7.4 - *voltage* and *reactive power* control

(3) 3.3.7.5 - *active power* control

(4) 3.3.7.6 - *inertia* and *frequency* control

(5) 3.3.7.7 - *frequency* disturbance ride through

(6) 3.3.7.8 - *voltage* disturbance ride through

(7) 3.3.7.9 - multiple disturbance ride through

(8) 3.3.7.10 - disturbance ride through for partial *load* rejection

(9) 3.3.7.11 - disturbance ride through for *quality of supply*

(10) 3.3.7.12 - quality of *electricity generated*

(b) All *small generating systems* with aggregate rated capacity less than or equal to 150 kVA must achieve the *common requirements* and *minimum generator performance standards* specified in the following clauses:

(1) 3.3.7.3 - *reactive power* capability

(2) 3.3.7.4 - *voltage* and *reactive power* control except:

(A) The *Network Service Provider* may approve the relaxation of performance requirements for *voltage*, *power factor* and *reactive power control systems* specified in clause 3.3.7.4(c) provided that would not result in the *generating system* operating in a manner that causes the *voltage* at the *connection point* to exceed the limits specified in clause 2.2.2 or 2.2.3.

(3) 3.3.7.6 - *inertia* and *frequency* control

(4) 3.3.7.7 - *frequency* disturbance ride through

(5) 3.3.7.8 - *voltage* disturbance ride through except:

(A) The *voltage* disturbance ride through requirements in clause **Error! Reference source not found.** are relaxed to the *voltage* limits specified in AS/NZS 4777.2

(6) 3.3.7.9 - multiple disturbance ride through except:

(A) The multiple disturbance ride through requirements in clause **Error! Reference source not found.** are relaxed to align with the l imits specified in AS/NZS 4777.2

(7) 3.3.7.12 - quality of *electricity generated*

Note:
There is no requirement for the *Network Service Provider* to involve *AEMO* in setting the technical performance required to meet the *minimum performance standards* specified in clause 3.6.5(a) and

3.6.5(b).

3.6.6 *Connection* and operation

3.6.6.1 *Generators*' substations

Generators' substations through which *generating units* are *connected* to the *transmission or distribution system* must comply with the requirements of clause 3.4.8.

3.6.6.2 Main switch

(a) Each *facility* at which one or more *generating units* in a *small generating system* is *connected* to the *transmission or distribution system* must contain one main switch provided by the *User* for each *connection point* and one *generator* main switch for each *generating unit*, where a *generating unit* shares a *connection point* with other *generating units* or *loads*. For larger installations, additional *connection points* and main switches or a dedicated feeder may be required.

(b) Switches must be circuit breakers or automatically operated, fault current breaking and making ganged switches. The relevant *facility* may also contain similarly rated interposed paralleling switches for the purpose of providing alternative synchronised switching operations.

(c) At each relevant *connection point* there must be a means of visible and lockable isolation and test points accessible to the *Network Service Provider's* operational personnel. This may be a withdrawable switch, a switch with visible contacts, a set of removable links or other approved means. The isolation point must be designed to allow the *Network Service Provider's* operational personnel to fit safety locks on the isolation point.

3.6.6.3 Synchronising

(a) For a *synchronous generating unit* in a *small generating system*, a *Generator* must provide automatic synchronising equipment at each *generating unit* circuit breaker.

(b) Check synchronising must be provided on all *generating unit* circuit breakers and any other switching devices that are capable of connecting the *User's generating equipment* to the *transmission or distribution system* unless otherwise interlocked to the satisfaction of the *Network Service Provider*.

(c) Prior to the initial *synchronisation* of the *generating unit(s)* to the *transmission or distribution system*, the *Generator* and the *Network Service Provider* must agree on written operational procedures for *synchronisation*.

3.6.6.4 Safe shutdown without external *supply*

A *generating unit* must be capable of being safely shut down without electricity *supply* being available from the *transmission or distribution system*.

3.6.6.5 Export limit control

(a) To ensure the safe, reliable and secure operation of the *power system* the *Network Service Provider* may specify an export limit for a *generating system* that is less than the rated capacity of the *generating system*.

(b) The *Generator* must control the *active power* produced by a *generating system* such that the *active power* injected into the *power system* at the *connection point* does not exceed any export limit specified by the *Network Service Provider*.

3.6.7 Power quality and *voltage* change

(a) A *Generator* connecting a *small generating system* to the *power system*, must provide information to enable assessment of whether the performance standards specified in clause 2.2 can continue to be met following the connection.

(b) The *voltage step change* at the *connection point* for *connection* and *disconnection* must comply with the requirements of clauses 2.2.2 and 2.2.3, as applicable.

> **Note:**
> These requirements may be achieved by synchronising individual *generating units* at intervals of at least two minutes.

3.6.8 Remote monitoring, control and communications

(a) For each *generating system* with aggregate rated capacity exceeding 1 MVA, the *Generator* must provide for:

(1) tripping of the *generating unit* remotely from the *Network Service Provider's control centre*;

(2) an interlock operated from the *Network Service Provider's control centre*; and

(3) remote monitoring at the *Network Service Provider's control centre* of (signed) MW, Mvar and *voltage* and applicable setpoints for *voltage, power factor* or *reactive power* controller provided to satisfy the requirements in clause 3.6.5.

(b) For *generating systems* with aggregate rated capacity less than or equal to 1 MVA monitoring may not be required. However, where concerns for *power system security*, safety or *power system reliability* arise that are not adequately addressed by automatic *protection systems* and interlocks, the *Network Services Provider* may require the *Generator* to provide remote monitoring and remote control of some functions in accordance with clause 3.6.8(a).

(c) For *generating systems* that are required to implement remote monitoring and control under clause 3.6.8(a) or 3.6.8(b), the *Generator* must provide a continuous communication link to the *Network Service Provider's control centre.*

(d) A *Generator* must have available at all times a telephone link or other communication channel to enable voice communications between a *small generating system* and the *Network Service Provider's control centre*.

3.6.9 Commissioning and testing

3.6.9.1 Commissioning

The *Generator* must comply with the testing and commissioning requirements for *generating units connected* to the *transmission or distribution system* specified in Attachment 12.

3.6.9.2 Re-confirmation of correct operation

(a) The *Network Service Provider* may inspect the *generating system* from time to time to confirm continued compliance with the requirements in these *Rules*.

(b) In the event that the *Network Service Provider* considers that the *generating system* does not meet the requirements of clause 3.5.1, 3.5.3 or 3.6, it may:

(1) request information on the settings for the *generating system* from the *User* or *Generator;*

(2) require testing or setting *changes* on the *generating system;* or

(3) *disconnect* the *generating system*.

(c) The *User* or *Generator* must conduct testing, implement setting *changes*, or *disconnect* the *generating system* if requested by the Network Service *Provider* in accordance with clause 3.6.9.2(b).

3.6.10 Technical matters to be coordinated

(a) The *Generator* and the *Network Service Provider* must agree upon the following matters in respect of each new or altered *connection*:

(1) design at *connection point*;

(2) physical layout adjacent to *connection point*;

(3) back-up (alternative) *supply* arrangements;

(4) *protection* and back-up;

(5) control characteristics;

(6) communications, metered quantities and alarms;

(7) insulation co-ordination and lightning protection;

(8) fault levels and fault clearing times;

(9) switching and isolation *facilities*;

(10) interlocking arrangements;

(11) synchronising *facilities*;

(12) under *frequency load shedding* and islanding schemes; and

(13) any special test requirements.

(b) As an alternative to *distribution system augmentation*, the *Network Service Provider* may require a *Generator* to provide additional control and *protection schemes* to ensure that operating limits and agreed import and export limits are not exceeded.

3.7 REQUIREMENTS FOR CONNECTION OF SMALL GENERATING SYSTEMS TO THE LOW VOLTAGE DISTRIBUTION SYSTEM

3.7.1 Overview

(a) This clause 3.7 addresses the particular requirements for the connection of *small generating systems* (i.e., *generating systems* of aggregate rated capacity less than or equal to 5 MVA) to the *low voltage distribution system*. This clause does not apply to the connection of *inverter energy systems* via a *standard connection service* to the *low voltage distribution system* (in which case clause 3.8 applies).

(b) A *Generator* responsible for a *small generating system connected* to the *low voltage distribution system,* other than via a *standard connection service,* must comply at all times with *protection* requirements specified in clause 3.5.1 and clause 3.5.3.

3.7.2 Categorisation of *facilities*

(a) This clause 3.7 covers *generating units* of all types, whether using renewable or non-renewable *energy* sources.

(b) Unless otherwise specified, technical requirements for *generating units* shall apply at the *connection point*, rather than at the *generating unit* terminals.

(c) Where a *small generating system* is the only *facility connected* to a *low voltage* network the *Generator* may choose to have the *power station* assessed for compliance as if the *power station* was *high voltage connected*. Prior to another *User* subsequently connecting to the same *low voltage* network the *Network Service Provider* must reassess the *power station* for compliance with the requirements for *low voltage connected power stations* and the *Generator* must rectify any non-compliance identified in the reassessment.

(d) This clause 3.7 differentiates the requirements applicable to *inverter connected generating systems* with AS/NZS 4777.2 compliant *inverters* from those applicable to other *generating systems*.

3.7.3 Information to be provided by the *Generator*

(a) A *Generator* for a *small generating system* must provide to the *Network Service Provider* information in relation to the design, construction, operation and configuration of that *small generating system* as is reasonably required to ensure that the operation and performance standards of the *power system,* or other *Users,* are not adversely affected by the operation of the *small generating system*. Details of the kinds of information that may be required are included in Attachment 10. Where considered necessary by the *Network Service Provider* additional information of the kind included in Attachment 3 may be required and shall be provided by the *Generator*.

(b) In order to allow the *Network Service Provider* to assess the impact of the *generating system* on the operation and performance of the *power system* or on other *Users,* a *Generator* must provide data on:

(1) *power station* and *generating unit* aggregate *active power* and *reactive power*;

(2) flicker coefficients and harmonic profile of the equipment. Data on power quality characteristics, including flicker and harmonics, in accordance with IEC 61400-21 must be provided for all wind turbines. Similar data may also be required for other *inverter connected generating systems* such as solar farms;

(3) net import / export data must be provided in the form of:

(A) a typical 24 hour power curve measured at 15 minute intervals (or better if available); and

(B) details of the maximum kVA output over a 60 second interval,

or such other form as specified in the relevant *connection agreement*.

(4) When requested by the *Network Service Provider*, a *Generator* must provide details of the proposed operation of the equipment during start-up, shut-down, normal daily operation, intermittent fuel or wind variations and under fault or *emergency conditions*.

3.7.4 Safety and contribution to *power system reliability*

(a) The requirements imposed on a *Generator* by this clause 3.7 are intended to provide minimum safety and reliability standards to protect the *power system* and other *User's* equipment. Safety, *power system reliability* and the *quality of supply* to other *Users* are paramount and *access applications* must be evaluated accordingly.

(b) A *Generator* shall not cause the *power system* performance to degrade below minimum safety and reliability standards for the *power system* or below minimum requirements that affect the *quality of supply* for other *Users*. In addition to meeting clause 3.7, the *Generator* must design and operate its *facilities* in accordance with applicable standards and regulations, *good electricity industry practice* and the manufacturers' recommendations.

(c) Where it is apparent that the operation of equipment installed in accordance with the requirements of this clause 3.7 may nevertheless have an adverse impact on the operation, safety or performance of the *power system*, or on the *quality of supply* to other *Users*, the *Network Service Provider* must consult with the *User* to reach an agreement on an acceptable solution. As a consequence, the *Network Service Provider* may require the *Generator* to test or modify its relevant equipment.

(d) Unless otherwise agreed in the relevant *connection agreement*, the *Network Service Provider* may require a *Generator* not to operate equipment in abnormal *power system* operating conditions.

3.7.5 Technical requirements

(a) All *small generating systems connected* to the *low voltage distribution system* via *inverters* must:

(1) use only *inverters* that comply with AS/NZS 4777.2, and

(2) implement control modes and control settings specified by the *Network Service Provider.*

(b) All non-*inverter connected small generating systems* with aggregate rated capacity greater than 150 kVA *connected* to the *low voltage distribution system* must achieve the *common requirements* and *minimum generator performance standards* specified in the following clauses:

(1) 3.3.7.3 - *reactive power* capability

(2) 3.3.7.4 - *voltage* and *reactive power* control

(3) 3.3.7.5 - *active power* control

(4) 3.3.7.6 - *inertia* and *frequency* control

(5) 3.3.7.7 - *frequency* disturbance ride through

(6) 3.3.7.8 - v*oltage* disturbance ride through, except the clause 3.3.7.8(c)(1) is replaced with the following:

(A) A *generating system* must maintain *continuous uninterrupted operation* where a *power system* disturbance causes the phase to phase *voltage* (for balanced 3 phase network) to vary within the following ranges:

(i) *voltage* does not exceed 480 V after T(ov);

(ii) *voltage* does not exceed 460 V for more than 0.1 seconds after T(ov);

(iii) *voltage* does not exceed 440 V for more than 0.9 seconds after T(ov);

(iv) *voltage* remains at 400 V for no more than 450 milliseconds after T(uv) subject to clause 3.3.7.8(c)(2);

(v) *voltage* does not stay below 280 V for more than 450 milliseconds after T(uv);

(vi) *voltage* does not stay below 320 V for more than 2.0 seconds after T(uv); and

(vii) *voltage* does not stay below 340 V for more than 5.0 seconds after T(uv).

Where:

T(ov) means a point in time when the *voltage* first varied above 440 V before returning to between 340 V and 440 V; and

T(uv) means a point in time when the *voltage* first varied below 340 V before returning to between 340 V and 440 V.

(7) 3.3.7.9 - multiple disturbance ride through

(8) 3.3.7.10 - disturbance ride through for partial *load* rejection

(9) 3.3.7.11 - disturbance ride through for *quality of supply*

(10) 3.3.7.12 - quality of *electricity generated*

(c) All non-*inverter connected small generating systems* with aggregate rated capacity less than or equal to 150 kVA *connected* to the *low voltage distribution system* must achieve the *common requirements* and *minimum generator performance standards* specified in the following clauses:

(1) 3.3.7.3 - *reactive power* capability

(2) 3.3.7.4 - *voltage* and *reactive power* control except:

(A) The *Network Service Provider* may approve the relaxation of performance requirements for *voltage*, *power factor* and *reactive power control systems* specified in clause 3.3.7.4(c) provided that would not result in the *generating system* operating in a manner that causes the *voltage* at the *connection point* to exceed the limits specified in clause 2.2.3.

(3) 3.3.7.6 - *inertia* and *frequency* control

(4) 3.3.7.7 - *frequency* disturbance ride through

(5) 3.3.7.8 - *voltage* disturbance ride through except:

(A) The *voltage* disturbance ride through requirements in clause **Error! Reference source not found.** are relaxed to the *voltage* limits specified in AS/NZS 4777.2

(6) 3.3.7.9 - multiple disturbance ride through except:

(A) The multiple disturbance ride through requirements in clause **Error! Reference source not found.** are relaxed to align with the limits specified in AS/NZS 4777.2

(7) 3.3.7.12 - quality of *electricity generated.*

Note:
There is no requirement for the *Network Service Provider* to involve *AEMO* in setting the technical performance required to meet the *minimum performance standards* specified in clause 3.7.5(b) and 3.7.5(c)

3.7.6 *Connection* and operation

3.7.6.1 Main switch

(a) Each *facility* at which one or more *generating units* in a *small generating system* is *connected* to the *low voltage distribution system* must comply with the main switch requirements in clause 3.2.2.

(b) At each relevant *connection point* there must be a means of visible and lockable isolation and test points accessible to the *Network Service Provider's* operational personnel.

3.7.6.2 Synchronising

(a) For a *synchronous generating unit* in a *small generating system*, a *Generator* must provide automatic synchronising equipment at each *generating unit* circuit breaker.

(b) Check synchronising must be provided on all *generating unit* circuit breakers and any other switching devices that are capable of connecting the *User's* or *Generator's generating equipment* to the *distribution system* unless otherwise interlocked to the satisfaction of the *Network Service Provider*.

(c) Prior to the initial *synchronisation* of the *generating unit(s)* to the *distribution system*, the *User* or *Generator* and the *Network Service Provider* must agree on written operational procedures for *synchronisation*.

3.7.6.3 Safe shutdown without external *supply*

A *generating unit* must be capable of being safely shut down without electricity *supply* being available from the *distribution system*.

3.7.6.4 Export limit control

(a) The *Network Service Provider* may specify an export limit for a *generating system* that is less than the rated capacity of the *generating system*.

(b) The *User* or *Generator* must control the *active power* produced by a *generating system* such that the *active power* injected into the *power system* at the *connection point* does not exceed any export limit specified by the *Network Service Provider*.

(c) The *Network Service Provider* may request information from a *User* or a *Generator* on any export limit control implemented in accordance with this clause and may request subsequent *changes* if the export limit control is considered inadequate.

(d) The *User* or *Generator* must provide information and implement any *changes* required in response to the *Network Service Provider's* request made under clause 3.7.6.4(c).

3.7.6.5 *Generation* limit control

(a) Where the *generating system* includes multiple energy source types, the *Network Service Provider* may specify *generation* limit control that is less than the total rated *generating system* capacity.

(b) The *User* or *Generator* must implement a *generation* limit that prevents the *apparent power* produced by the *small generating system* exceeding any limit specified by the *Network Service Provider*.

> **Note:**
> Multiple energy source types may include battery energy storage and a combination of other energy sources.

(c) The *Network Service Provider* may request information from the *User* or *Generator* on any *generation* limit control implemented in accordance with this clause and may request subsequent *changes* if the *generation* limit control is considered inadequate.

(d) The *User* or *Generator* must provide information and implement any *changes* required in response to the *Network Service Provider's* request made under clause 3.7.6.5(c).

3.7.7 Power quality and *voltage change*

(a) A *Generator* connecting a *small generating system* to the *power system*, must provide information to enable assessment of whether the performance standards specified in clause 2.2 can continue to be met following the connection.

(b) The *voltage step change* at the *connection point* for *connection* and *disconnection* must comply with the requirements of clause 2.2.3. On *low voltage* feeders, *voltage* changes up to 5% may be allowed in some circumstances with the approval of the *Network Service Provider*.

> **Note:**
> The requirements of clause 3.7.7(b) may be achieved by synchronising individual *generating units* at intervals of at least two minutes.

3.7.8 Remote monitoring, control and communications

(a) For a *generating system* connecting to the *low voltage distribution system* via a connection service other than a *standard connection service*, the *User* or *Generator* must:

(1) comply with the requirements of clause 3.6.8, and

(2) the *Network Service Provider* may specify additional requirements for the *User* or *Generator* to enable remote monitoring and control of the *generating system.*

(b) Where additional requirements are specified under clause 3.7.8(a)(2) the *User* or *Generator* must implement them.

(c) The *Network Service Provider* may request information from a *User* or a *Generator* on any remote monitoring and control implemented in accordance with this clause and may request subsequent *changes* if the remote monitoring and control is considered inadequate.

(d) The *User* or *Generator* must provide information and implement any *changes* required in response to the *Network Service Provider's* request made under clause 3.7.8(c).

3.7.9 Commissioning and testing

3.7.9.1 Commissioning

The *User* or *Generator* must comply with the testing and commissioning requirements for *generating units connected* to the *distribution system* specified in Attachment 12.

3.7.9.2 Re-confirmation of correct operation

(a) The *Network Service Provider* may inspect the *generating system* from time to time to confirm continued compliance with the requirements in these *Rules*.

(b) In the event that the *Network Service Provider* considers that the *generating system* does not meet the requirements of clause 3.5.1, 3.5.3 or 3.7, it may:

  (1) request information on the settings for the *generating system* from the *User* or *Generator;*

  (2) require testing or setting *changes* on the *generating system*; or

  (3) *disconnect* the *generating system*.

(c) The *User* or *Generator* must conduct testing, implement setting *changes*, or *disconnect* the *generating system* if requested by the Network Service *Provider* in accordance with clause 3.7.9.2(b).

3.7.10 Technical matters to be coordinated

(a) The *User* or *Generator* and the *Network Service Provider* must agree on the following matters in respect of each new or altered *connection*:

  (1) design at *connection point*;

  (2) physical layout adjacent to *connection point*;

  (3) alternative *supply* arrangements;

  (4) *protection* and *back-up protection systems*;

  (5) control characteristics;

  (6) communications, metered quantities and alarms;

  (7) insulation co-ordination and lightning protection;

  (8) fault levels and fault clearing times;

(9) switching and isolation *facilities*;

(10) interlocking arrangements;

(11) synchronising *facilities*;

(12) under *frequency load shedding* and islanding schemes; and

(13) any special test requirements.

(b) The *Network Service Provider* may provide a *User* or *Generator* with additional *protection* or control for their *small generating system* as an alternative to *distribution system augmentation*.

(c) Where additional *protection* or control is required under clause 3.7.10(b), the *User* or *Generator* must comply with agreed functions and operating limits (including import and export limits).

3.8 REQUIREMENTS FOR CONNECTION OF INVERTER ENERGY SYSTEMS CONNECTED TO THE LOW VOLTAGE DISTRIBUTION SYSTEM VIA A STANDARD CONNECTION SERVICE

3.8.1 Overview

(a) This clause 3.8 addresses the particular requirements for the connection of *inverter energy systems* to the *Network Service Provider's low voltage distribution system* that can be *connected* via a *standard connection service*.

(b) Where the *inverter energy system* requires a connection service other than a *standard connection service*, the requirements of clause 3.7 apply.

(c) Nothing in this clause 3.8 obliges the *Network Service Provider* to approve the connection of an *inverter energy system* to the *low voltage distribution system* if it considers that the *power system* performance standards specified in clause 2.2 will not be met as a consequence of the operation of the *inverter energy systems*.

(d) All *inverter energy systems connected* via a *standard connection service* to the *low voltage distribution* network must comply with AS/NZS 4777 series and must achieve the additional requirements specified in this clause 3.8.

(e) An *inverter energy system connected* via a *standard connection service* to the *low voltage distribution* network must comply at all times with *protection* requirements specified in clause 3.5.1 and clause 3.5.4.

3.8.2 *Energy* system capacity, imbalance and assessment

(a) It is the responsibility of the *Network Service Provider* to carry out a connection assessment for the following *inverter energy systems connected* via *standard connection services* to confirm that the *power system* performance standards specified in clause 2.2 will be met when the *inverter energy system* is operating at its full rated capacity:

  (1) single phase *inverter* connections rated greater than 5 kVA,

  (2) three phase *inverter* connections with more than 2.5 kVA imbalance on three phase connection services between any two phases, and

  (3) connections that are beyond any other maximum threshold determined by the *Network Service Provider*.

> **Note:**
> For *inverter energy systems* connecting at levels below the thresholds in this clause, assessment is not necessarily required. However, the *Network Service Provider* can use discretion under clause 3.8.2(b) if it considers assessment is necessary.

(b) The *Network Service Provider* may carry out the assessment of connections below the thresholds in clause 3.8.2(a) if it deems necessary.

(c) The *inverter energy system* must not cause a *voltage* rise across the service leads that exceeds 1% of the connection *voltage*.

3.8.3 Relevant standards

(a) A *User* must only use *inverters* that have a type-test report or type-test certificate from an independent and recognised certification body showing compliance of the *inverter* with AS/NZS 4777.2. Evidence of this must be supplied to the *Network Service Provider* on request.

(b) *Inverter energy systems* must be designed, installed and commissioned in accordance with relevant *Australian Standards* and *good electricity industry practice*.

(c) Only *inverter energy systems* that have been assessed and approved by the *Network Service Provider* shall be installed.

3.8.4 Safety

3.8.4.1 General

(a) Installations must comply with all statutory requirements and the relevant *Australian Standards*, including *AS*/NZS 3000, *AS*/NZS 5033 and *AS*/NZS 4777 series.

(b) All electrical installation, commissioning and maintenance work wherever required must be carried out by an electrical contractor licensed under the Electricity (Licensing) Regulations, 1991.

(c) Any *changes* to any parameter on an installed *inverter energy system* must be approved by the *Network Service Provider*.

3.8.4.2 Security of operational settings

(a) Where operational settings are applied via a keypad or switches, adequate security must be employed to prevent tampering, inadvertent or unauthorised *changes* to these settings. A suitable lock or password system must be used. The *Network Service Provider* must approve *changes* to settings prior to implementation.

(b) The *Network Service Provider* may require the *User* to demonstrate that the operational settings implemented in the *inverter energy system* are those approved by the *Network Service Provider*.

(c) The *User* or the *Generator* must provide the *Network Service Provider* with evidence of inspected settings in response to any request made in accordance with clause 3.8.4.2(b).

3.8.5 Connection and operation

3.8.5.1 Main switch

(a) All *inverter energy systems connected* to the *low voltage distribution system* via a *standard connection service* must comply with the main switch requirements in clause 3.2.2.

(b) At each relevant *connection point* there must be a means of visible and lockable isolation and test points accessible to the *Network Service Provider's* operational personnel.

3.8.5.2 Export limit control

(a) To ensure the safe, reliable and secure operation of the *power system* the *Network Service Provider* may specify an export limit for an *inverter energy system* that is less than the *inverter energy system* rated capacity.

(b) The *User* or *Generator* must control the *active power* produced by an *inverter energy system* such that the *active power* injected into the *low voltage distribution system* at the *connection point* does not exceed any export limit specified by the *Network Service Provider*.

(c) The *Network Service Provider* may request information from a *User* or a *Generator* on any export limit control implemented in accordance with this clause and may request subsequent *changes* if the export limit control is considered inadequate.

(d) The *User* or *Generator* must provide information and implement any *changes* required in response to the *Network Service Provider's* request made under clause 3.8.5.2(c).

3.8.5.3 *Generation* limit control

(a) Where the *inverter energy system* includes multiple energy source types, the *Network Service Provider* may specify *generation* limit control that is less than the total rated *inverter energy system* capacity.

(b) The *User* or *Generator* must implement a *generation* limit that prevents the *apparent power* produced by the *inverter energy system* exceeding any limit specified by the *Network Service Provider*.

> **Note:**
> Multiple energy source types may include battery energy storage and a combination of other energy sources.

(c) The *Network Service Provider* may request information from a *User* or a *Generator* on any export limit control implemented in accordance with this clause and may request subsequent *changes* if the export limit control is considered inadequate.

(d) The *User* or *Generator* must provide information and implement any *changes* required in response to the *Network Service Provider's* request made under clause 3.7.8(c).

3.8.6 Remote monitoring, control and communications

(a) The *Network Service Provider* may specify requirements for the *User* or *Generator* to enable remote monitoring and control of an *inverter energy system*.

(b) Where additional requirements are specified under clause 3.8.6(a) the *User* or *Generator* must implement them.

(c) The *Network Service Provider* may request information on any remote monitoring and control implemented in accordance with this clause and may request subsequent *changes* if the remote monitoring and control is considered inadequate.

(d) The *User* or *Generator* must provide information and implement any *changes* required in response to the *Network Service Provider's* request made under clause 3.8.6(c).

3.8.7 Commissioning and testing

3.8.7.1 Exclusion of clause 4.1.3 and 4.2

(a) The requirements for commissioning and testing of *inverter energy systems connected* to the *low voltage distribution system* via a *standard connection service* defined in this clause 3.8.6(c) take precedence over requirements defined in clause 4.2.

(b) Clause 4.1.3 does not apply to *inverter energy system* covered by clause 3.8.

3.8.7.2 Commissioning

(a) Commissioning may occur only after the installation of the metering equipment.

(b) In commissioning equipment installed under this clause 3.8, a *User* or *Generator* must comply with the commissioning requirement specified in AS/NZS 4777.1.

(c) Subsequent modifications to the *inverter* installation must be submitted to the *Network Service Provider* for approval.

3.8.7.3 Re-confirmation of correct operation

(a) The *Network Service Provider* may elect to inspect an *inverter energy system* from time to time to ensure continued compliance with the requirements in these *Rules*.

(b) In the event that the *Network Service Provider* considers that the *inverter energy system* does not meet the requirements of clause 3.5.1, 3.5.4 or 3.8, it may:

   (1) request information on the settings for the *inverter energy system* from the *User* or *Generator;*

   (2) require testing or setting *changes* on the *inverter energy system*; or

   (3) *disconnect* the *inverter energy system*.

(c) The *User* or *Generator* must conduct testing, implement setting *changes*, or *disconnect* the *inverter energy system* if requested by the *Network Service Provider* in accordance with clause 3.8.7.3(b).

4. *INSPECTION, TESTING, COMMISSIONING, DISCONNECTION AND RECONNECTION*

4.1 INSPECTION AND TESTING

4.1.1 Right of entry and inspection

(a) The *Network Service Provider* or *AEMO* (in this clause 4.1.1 the "inspecting party") may, in accordance with this clause 4.1.1, enter and inspect any *facility* of the *Network Service Provider* or any *User* whose equipment is *connected* directly to the *transmission system* and who is bound by these *Rules* (in this clause 4.1.1 the "*facility* owner") and the operation and maintenance of that *facility* in order to:

(1) assess compliance by the *facility* owner with its obligations under the *Access Code* or these *Rules*, or any relevant *connection agreement*;

(2) investigate any operating incident in accordance with clause 5.4.4.3;

(3) investigate any potential threat by that *facility* to *power system security*; or

(4) conduct any periodic familiarisation or training associated with the operational requirements of the *facility*.

(b) If an inspecting party wishes to inspect a *facility* under clause 4.1.1(a), the inspecting party must give the *facility* owner at least:

(1) 2 *business days'* notice or as otherwise agreed by the parties, or

(2) 10 *business days'* notice for a non-urgent issue,

in writing of its intention to carry out an inspection.

(c) In the case of an emergency condition affecting the *transmission or distribution system* that the *Network Service Provider* or *AEMO* reasonably considers requires access to a *facility*, prior notice to the *facility* owner is not required. However, the *Network Service Provider* or *AEMO*, as applicable, must notify the *facility* owner as soon as practicable of the nature and extent of the activities it proposes to undertake, or which it has undertaken, at the *facility*.

(d) A notice given by an inspecting party under clause 4.1.1(b) must include the following information:

(1) the name of the inspecting party's *representative* who will be conducting the inspection;

(2) the time when the inspection will commence and the expected time when the inspection will conclude; and

(3) the relevant reasons for the inspection.

(e) An inspecting party must not carry out an inspection under this clause 4.1.1 within 6 *months* of any previous inspection by it, except for the purpose of verifying the performance of corrective action claimed to have been carried out in respect of a non-conformance observed and documented on the previous inspection or for the purpose of investigating an operating incident in accordance with clause 5.4.4.3.

(f) At any time when the *representative* of an inspecting party is in a *facility* owner's *facility*, that *representative* must:

(1) not cause any damage to the *facility*;

(2) interfere with the operation of the *facility* only to the extent reasonably necessary and as approved by the *facility* owner (such approval not to be unreasonably withheld or delayed);

(3) observe "permit to test" access to site and clearance protocols applicable to the *facility*, provided that these are not used by the *facility* owner or any contractor or agent of the *facility* owner solely to delay the granting of access to the *facility* or its inspection;

(4) observe the requirements in relation to occupational health and safety and industrial relations matters which are of general application to all invitees entering on or into the *facility*, provided that these requirements are not used by the *facility* owner or any contractor or agent of the *facility* owner solely to delay the granting of access to the *facility*; and

(5) not ask any question other than as may be reasonably necessary for the purpose of such inspection, nor give any direction or instruction to any person involved in the operation or maintenance of the *facility* other than in accordance with these *Rules* or, where the inspecting party and the *facility* owner are parties to a *connection agreement*, that *connection agreement*.

(g) Any *representative* of an inspecting party conducting an inspection under this clause 4.1.1 must be appropriately qualified and experienced to perform the relevant inspection. If so requested by the *facility* owner, the inspecting party must procure that its *representative* (if not a direct employee of the inspecting party) enters into a confidentiality undertaking in favour of the *facility* owner in a form reasonably acceptable to the *facility* owner prior to seeking access to the relevant *facility*.

(h) An inspection under this clause 4.1.1 must not take longer than one day unless the inspecting party seeks approval from the *facility* owner for an extension of time (which approval must not be unreasonably withheld or delayed).

(i) Any equipment or goods installed or left on land or in premises of a *facility* owner after an inspection conducted under this clause 4.1.1 do not become the property of the *facility* owner (notwithstanding that they may be annexed or affixed to the land on which the *facility* is situated).

(j) In respect of any equipment or goods left by an inspecting party on land or in premises of a *facility* owner during or after an inspection, the *facility* owner must, and must procure that any person who owns or occupies the land on which the *facility* is situated or any part thereof does:

(1) take reasonable steps to ensure the security of any such equipment;

(2) not use any such equipment or goods for a purpose other than as contemplated in these *Rules* without the prior written approval of the inspecting party;

(3) allow the inspecting party to remove any such equipment or goods in whole or in part at a time agreed with the *facility* owner, which agreement must not be unreasonably withheld or delayed; and

(4) not create or cause to be created any mortgage, charge or lien over any such equipment or goods.

4.1.2 Right of testing

(a) If the *Network Service Provider* or any *User* whose equipment is *connected* directly to the *transmission system* under a *connection agreement* (in this clause 4.1.2 the "requesting party") believes that equipment owned or operated by, or on behalf of, the other party to the *connection agreement* (in this clause 4.1.2 the "equipment owner") may not comply with the *Access Code*, these *Rules* or the *connection agreement*, the requesting party may require testing by the equipment owner of the relevant equipment by giving notice in writing to the equipment owner accordingly.

(b) If a notice is given under clause 4.1.2(a), the relevant test must be conducted at a reasonable time mutually agreed by the requesting party and the equipment owner and, where the test may have an impact on *power system security*, *AEMO* or the *Network Service Provider* as the case requires. Such agreement must not be unreasonably withheld or delayed.

(c) An equipment owner who receives a notice under clause 4.1.2(a) must co-operate in relation to conducting the tests requested by that notice.

(d) Tests conducted in respect of a *connection point* under this clause 4.1.2 must be conducted using test procedures agreed between the *Network Service Provider*, the relevant *Users* and, where appropriate, *AEMO*, which agreement must not be unreasonably withheld or delayed.

(e) Tests under this clause 4.1.2 must be conducted or supervised only by persons with the relevant skills and experience in the commissioning or testing of *power system primary equipment* and *secondary equipment*.

(f) A requesting party may appoint a *representative* to witness the test requested by it under this clause 4.1.2 and the equipment owner must permit a *representative* so appointed to be present while the test is being conducted.

(g) Subject to clause 4.1.2(h), an equipment owner who conducts a test must submit a report to the requesting party and, where the test was one that could have had an impact on *power system security*, *AEMO* or the *Network Service Provider* as the case requires, within a reasonable period after the completion of the test. The report must outline relevant details of the tests conducted, including, but not limited to, the results of those tests.

(h) The *Network Service Provider* may attach test equipment or *monitoring* equipment to equipment owned by a *User* or require a *User* to attach such test equipment or *monitoring* equipment, subject to the provisions of clause 4.1.1 regarding entry and inspection. The data from any such test equipment or *monitoring* equipment must be read and recorded by the equipment owner.

(i) In carrying out monitoring under clause 4.1.2(h), the *Network Service Provider* must not cause the performance of the monitored equipment to be constrained in any way.

(j) If a test under this clause 4.1.2 or monitoring under clause 4.1.2(h) demonstrates that equipment does not comply with the *Access Code*, these *Rules* or the relevant *connection agreement*, then the equipment owner must:

(1) promptly notify the requesting party of that fact;

(2) promptly advise the requesting party of the remedial steps it proposes to take and the timetable for such remedial work;

(3) diligently undertake such remedial work and report at *monthly* intervals to the requesting party on progress in implementing the remedial action; and

(4) conduct further tests or monitoring on completion of the remedial work to confirm compliance with the relevant requirement.

4.1.3 Tests to demonstrate compliance with *connection* requirements for *generators*

A *Generator* who has developed a set of Generator Performance Standards and a GPS Monitoring Plan by applying the process defined in clause 3A of the *WEM Rules* must adhere to the compliance framework in the *WEM Rules.* The arrangements defined in clause 4.1.3 apply to all other *Generators.*

(a) (1) A *Generator* must provide evidence to the *Network Service Provider* that each of its *generating units* complies with the technical requirements of Chapter 3, as applicable, and the relevant *connection agreement* prior to commencing commercial operation. In addition, each *Generator* must cooperate with the *Network Service Provider* and, if necessary, *AEMO* in carrying out *power system* tests prior to commercial operation in order to verify the performance of each *generating unit*, and provide information and data necessary for computer model validation. The test requirements for *synchronous generating units* are detailed in Table A11.1 of Attachment 11. The *Network Service Provider* must specify test requirements for *asynchronous generation*. If tests reveal that the computer model provided by the *Generator* in accordance with clause 3.3.11 requires amendment, the *Generator* must provide an update to the *generation* system model in accordance with the *generation* system model procedure developed by the *Network Service Provider*.

(2) Special tests may be specified by the *Network Service Provider* or *AEMO* where reasonably necessary to confirm that the performance standards of the *power system*, *power system security* and the quality of service to other *Users* will not be adversely affected by the connection or operation of a *Generator*'s equipment. The requirement for such tests must be determined on a case by case basis and the relevant *Generator* must be advised accordingly. Examples of these special tests are listed in Table A11.2 of Attachment 11. Where testing is not practicable in any particular case, the *Network Service Provider* may require the *Generator* to install recording equipment at appropriate locations in order to monitor equipment performance.

(3) A *Generator* may be required to undertake compliance tests as described in clause 4.1.3(a) following any *relevant generator modification* or *triggered event.*

(4) These compliance tests must only be performed after the machines have been tested and certified by a chartered professional engineer with National Engineering Register standing qualified in a relevant discipline, unless otherwise agreed, and after the machine's turbine controls, AVR, excitation limiters, power system stabiliser, and associated *protection* functions have been calibrated and tuned for commercial operation to ensure stable operation both on-line and off-line. All final settings of the AVR, PSS and excitation limiters must be indicated on control transfer block diagrams and made available to the *Network Service Provider* before the tests.

(5) All compliance tests under this clause 4.1.3 must be carried out under the supervision of personnel experienced in the commissioning or testing of *power system primary equipment* and *secondary equipment*.

(6) A *Generator* must forward test procedures for undertaking the compliance tests required in respect of its equipment, including details of the recorders and measurement equipment to be used in the tests, to the *Network Service Provider* for approval 30 *business day*s before the tests or as otherwise agreed. The *Generator* must provide all necessary recorders and other measurement equipment for the tests.

(7) A *Generator* must also coordinate the compliance tests in respect of its equipment and liaise with all parties involved, including the *Network Service Provider* and *AEMO*. The *Network Service Provider* or *AEMO* may

witness the tests and must be given access to the site for this purpose, but responsibility for carrying out the tests remains with the *Generator*.

(8) All test results and associated relevant information including final transfer function block diagrams and settings of automatic *voltage* regulator, *power system* stabiliser, under excitation limiter and over excitation limiter must be forwarded to the *Network Service Provider* within 10 *business days* after the completion of the test.

(b) A *Generator* must negotiate in good faith with the *Network Service Provider* and agree on a compliance monitoring program, following commissioning, for each of its *generating units* to confirm ongoing compliance with the applicable technical requirements of clause 3.3, as applicable, and the relevant *connection agreement*. The negotiations must consider the use of high speed data recorders and similar non-invasive methods for verifying the equipment performance to the extent that such non-invasive methods are practicable.

(1) When developing the compliance monitoring program, the *Generator* and the *Network Service Provider* should be guided by the GPS Monitoring Plan template developed by *AEMO* under the *WEM Rules*. The monitoring program should define:

(A) how the *Generator* will monitor performance against the applicable technical requirements including any testing and verification requirements;

(B) the record keeping obligations relating to monitoring compliance with technical requirements the *Generator* must comply with; and

(C) the information and data provision obligations the *Generator* must comply with when requested by the *Network Service Provider*, including the form and timeframes by which that information and data must be provided.

(2) The *Generator* must review and amend the compliance monitoring program following any *relevant generator modification* to the *generating system* or revision of any of the technical requirements applicable to the *generating system*.

(3) The *Generator* must review and amend the compliance monitoring program following any revision to the GPS Monitoring Plan template developed by *AEMO* under the *WEM Rules*.

(4) Before agreeing to a monitoring program the *Network Service Provider* may consult with *AEMO.*

(5) The *Network Service Provider* must include the compliance test results, the agreed compliance monitoring program and any results obtained through the execution of the compliance monitoring program in the register of performance requirements defined in clause 3.2.6.

(c) If compliance testing or monitoring of in-service performance demonstrates that a *generating system* is not complying with one or more technical requirements of clause 3.3 and the relevant *connection agreement* then the *Generator* must:

(1) promptly notify the *Network Service Provider* of that fact;

(2) promptly advise the *Network Service Provider* of the proposed *rectification plan* containing the remedial steps it proposes to take and the timetable for such remedial work to address the non compliance;

(3) diligently undertake such remedial work defined in the approved *rectification plan* and report at *monthl*y intervals to the *Network Service Provider* on progress in implementing the remedial action; and

(4) conduct further tests or monitoring on completion of the remedial work to confirm compliance with the relevant technical requirement.

(d) The *Network Service Provider* must consult with *AEMO* on any *power system security* implications prior to approving any proposed *rectification plan*.

(e) The *Network Service Provider* must use best endeavours to respond to the *Generator* within 10 *business days* of receipt of the proposed *rectification plan* and either:

(1) approve the proposed *rectification plan*;

(2) reject the proposed *rectification plan* providing reasons for the rejection, including, if applicable, any reasons provided by *AEMO*;

(3) seek further information needed to assess the suitability of the proposed *rectification plan*; or

(4) propose an alternative *rectification plan* the *Network Service Provider* considers would be acceptable.

(f) If a *Generator* reasonably considers it is unable to meet or comply with the requirements of an approved *rectification plan* it must notify the *Network Service Provider* as soon as reasonably practicable and may propose an amendment to the approved *rectification plan*.

(g) Where a *Generator* considers that compliance with an approved *rectification plan* will pose a credible safety risk or threaten *power system security* or *power system reliability*, it must immediately notify the *Network Service Provider* and:

(1) provide details of the actions required by the *rectification plan* that pose the safety risk or threat to *power system security* or *power system reliability*; and

(2) propose amendments to the *rectification plan* to address the safety risk or threat to *power system security* or *power system reliability*.

(h) While amendments are being developed in accordance with clause 4.1.3(g), the *Generator* is only required to comply with the requirements of the approved *rectification plan* that do not pose a safety risk or threat to *power system security* or *power system reliability* unless the *Network Service Provider* advises that the *Generator* can suspend compliance while the proposed amendment is developed and considered.

(i) If a *Generator* proposes an amendment to an approved *rectification plan*, the *Network Service Provider* may:

(1) approve the proposed amendment to the *rectification plan*; or

(2) reject the proposed amendment to the *rectification plan* and, at the *Network Service Provider's* discretion, propose an alternative amendment to the *rectification plan* if it considers a suitable alternative is available, which must be accepted or rejected by the *Generator* within 5 *business days* or such longer period agreed by the *Network Service Provider*.

(j) Before approving a proposed amendment to a *rectification plan*, the *Network Service Provider* should consult with *AEMO* on any *power system security* implications.

(k) If the *Network Service Provider* reasonably considers a *Generator* has not complied, or is not complying, with the requirements of an approved *rectification plan* and any approved amendments, the *Network Service Provider* may after consulting with *AEMO* on any *power system security* implications take action to address the risk posed by the continued non-compliance. Action may include:

(1) issuing a written notice to the *Generator* advising that the *Network Service Provider* considers that the *Generator* has not complied with the requirement of the approved *rectification plan* and any approved amendments and seeking an explanation from the *Generator* within a reasonable time not less than 5 *business days*;

(2) depending on the explanation received, cancelling an approved *rectification plan* and requiring a modified plan be developed; and

(3) directing the *Generator* in accordance with Clause 5.3.3(d) to restrict the operation of the *generating system* to manage the risk posed by the non-compliance.

(l) If the *Network Service Provider* or, where relevant, *AEMO* reasonably believes that a *generating unit* is not complying with one or more technical requirements of Chapter 3 or the relevant *connection agreement*, the *Network Service Provider* or *AEMO* may require the *Generator* to conduct tests within an agreed time to demonstrate that the relevant *generating unit* complies with those technical requirements and if the tests provide evidence that the relevant *generating unit* continues to comply with the technical requirement(s), whichever of the *Network Service Provider* or *AEMO* that requested the tests must reimburse the *Generator* for the reasonable expenses incurred as a direct result of conducting the tests.

(m) If the *Network Service Provider* or, where relevant, *AEMO*:

(1) has reason to believe that a *generating unit* does not comply with one or more of the requirements of Chapter 3;

(2) has reason to believe that a *generating unit* does not comply with the requirements for *protection schemes* set out in clause 2.9, as those requirements apply to the *Generator* under clause 3.5; or

(3) either:

(A) does not have evidence demonstrating that a *generating unit* complies with the technical requirements set out in Chapter 3; or

(B) holds the opinion that there is, or could be, a threat to the *power system security* or *power system stability*,

the *Network Service Provider* or, where relevant, *AEMO,* may direct the relevant *Generator* to operate the relevant *generating unit* at a particular *generated* output or in a particular mode of operation until the relevant *Generator* submits evidence reasonably satisfactory to the *Network Service Provider* or, where relevant, *AEMO*, that the *generating unit* is complying with the relevant technical requirement. If such a *direction* is given orally, the *direction*, and the reasons for it, must be confirmed in writing to the *Generator* as soon as practicable after the *direction* is given.

(n) If:

(1) the *Network Service Provider* or, where relevant, *AEMO*, gives a *direction* to a *Generator* under clause 4.1.3(m) and the *Generator* neglects or fails to comply with that *direction*; or

(2) the *Network Service Provider* or, where relevant, *AEMO*, endeavours to communicate with a *Generator* for the purpose of giving a *direction* to a *Generator* under clause 4.1.3(m) but is unable to do so within a time which is reasonable, having regard to circumstances giving rise to the need for the *direction*,

then the *Network Service Provider* or *AEMO*, as the case requires, may take such measures as are available to it (including, in the case of *AEMO*, issuing an appropriate *direction* to the *Network Service Provider* to take measures) to cause the relevant *generating unit* to be operated at the required *generated* output or in the required mode, or *disconnect* the *generating unit* from the *power system*.

(o) A *direction* under clause 4.1.3(m) must be recorded by the *Network Service Provider* or *AEMO*, as applicable.

(p) From the *Rules commencement date*, each *Generator* must maintain records and retain them for a minimum of 7 years (from the date of creation of each record) for each of its *generating units* and *power stations* setting out details of the results of all technical performance and monitoring conducted under this clause 4.1.3 and make these records available to the *Network Service Provider* or *AEMO* on request.

4.1.4 Routine testing of *protection* equipment

(a) A *User* must cooperate with the *Network Service Provider* to test the operation of equipment forming part of a *protection scheme* relating to a *connection point* at which that *User* is *connected* to a *transmission or distribution system* and the *User* must conduct these tests:

(1) prior to the equipment at the relevant *connection point* being placed in service; and

(2) at intervals specified in the *connection agreement* or in accordance with an asset management plan agreed between the *Network Service Provider* and the *User*.

(b) A *User* must, on request from the *Network Service Provider*, demonstrate to the *Network Service Provider's* satisfaction the correct calibration and operation of the *User's protection* at the *User's connection point*.

(c) The *Network Service Provider* and, where applicable, a *User*, must institute and maintain a compliance program to ensure that each of its *facilities* of the following types, to the extent that the proper operation of any such *facility* may affect *power system security* and the ability of the *power system* to meet the performance standards specified in clause 2.2, operates reliably and in accordance with its relevant performance requirements specified in Chapter 2:

(1) *protection systems*;

(2) *control systems* for maintaining or enhancing *power system stability*;

(3) *control systems* for controlling *voltage* or *reactive power*; and

(4) *control systems* for *load shedding*.

(d) A compliance program under clause 4.1.4(c) must:

(1) include monitoring of the performance of the *facilities*;

(2) to the extent reasonably necessary, include provision for periodic testing of the performance of those *facilities* upon which *power system security* depends;

(3) provide reasonable assurance of ongoing compliance of the *power system* with the performance standards specified in clause 2.2; and

(4) be in accordance with *good electricity industry practice*.

(e) The *Network Service Provider* and, where applicable, a *User*, must notify *AEMO* immediately if it reasonably believes that a *facility* of the type listed in clause 4.1.4(c), and forming part of a registered *facility*, does not comply with, or is unlikely to comply with, relevant performance requirements specified in Chapter 2.

4.1.5 Testing by *Users* of their own equipment requiring *change*s to agreed operation

(a) If a *User* proposes to conduct a test on equipment related to a *connection point* and that test requires a *change* to the operation of that equipment as specified in the relevant *connection agreement*, or if the *User* reasonably believes that the test might have an impact on the operation or performance of the *power system*, the *User* must give notice in writing to the *Network Service Provider* at least 15 *business day*s in advance of the test, except in an emergency.

(b) The notice to be provided under clause 4.1.5(a) must include:

(1) the nature of the proposed test;

(2) the estimated start and finish time for the proposed test;

(3) the identity of the equipment to be tested;

(4) the *power system* conditions required for the conduct of the proposed test;

(5) details of any potential adverse consequences of the proposed test on the equipment to be tested;

(6) details of any potential adverse consequences of the proposed test on the *power system*; and

(7) the name of the person responsible for the coordination of the proposed test on behalf of the *User*.

(c) The *Network Service Provider* must review the proposed test to determine whether the test:

(1) could adversely affect the normal operation of the *power system*;

(2) could cause a threat to *power system security*;

(3) requires the *power system* to be operated in a particular way which differs from the way in which the *power system* is normally operated;

(4) could affect the normal metering of *energy* at a *connection point*;

(5) could threaten public safety; or

(6) could damage equipment at the *connection point*.

(d) If, in the *Network Service Provider's* opinion, a test could threaten public safety, damage or threaten to damage equipment or adversely affect the operation, performance or *power system security*, the *Network Service Provider* may direct that the proposed test procedure be modified or that the test not be conducted at the time proposed. Where appropriate, the *Network Service Provider* must consult with *AEMO* in determining the nature of any modified test procedure or the appropriate time for the test to be conducted.

(e) The *Network Service Provider* must advise any other *Users* who will be adversely affected by a proposed test and consider any requirements of those *Users* when approving the proposed test.

(f) The *User* who conducts a test under this clause 4.1.5 must ensure that the person responsible for the coordination of the test promptly advises the *Network Service Provider* and, where appropriate, *AEMO*, when the test is complete.

(g) If the *Network Service Provider* approves a proposed test, the *Network Service Provider* and, where appropriate, *AEMO* must ensure that *power system* conditions reasonably required for that test are provided as close as is reasonably practicable to the proposed start time of the test and continue for the proposed duration of the test.

(h) Within a reasonable period after any such test has been conducted, the *User* who has conducted a test under this clause 4.1.5 must provide the *Network Service Provider* and, where appropriate, *AEMO*, with a report in relation to that test, including test results where appropriate.

(i) Any tests completed under this clause 4.1.5 must be carried out under the supervision of personnel experienced in the commissioning or testing of *power system primary equipment* and *secondary equipment*.

4.1.6 Tests of *generating units* requiring *changes* to agreed operation

(a) The *Network Service Provider* may, at intervals of not less than 12 *months* per *generating unit*, by notice to the relevant *Generator* accordingly, require the testing of any *generating unit connected* to the *transmission or distribution system* in order to determine analytic parameters for modelling purposes or to assess the performance of the relevant *generating unit*.

(b) The *Network Service Provider* must, in consultation with the *Generator*, propose a date and time for the tests but, if the *Network Service Provider* and the *Generator* are unable to agree on a date and time for the tests, they must be conducted on the date and at the time nominated by the *Network Service Provider*, provided that:

(1) the tests must not be scheduled for a date earlier than 15 *business days* after notice is given by the *Network Service Provider* under clause 4.1.6(a);

(2) the *Network Service Provider* must ensure that the tests are conducted at the next scheduled *outage* of the relevant *generating unit* or at some other

time which will minimise the departure from the *commitment* and *dispatch* that is anticipated to take place at that time; and

(3) in any event, the tests must be conducted no later than 9 *months* after notice is given by the *Network Service Provider* under clause 4.1.6(a).

(c) A *Generator* must provide any reasonable assistance requested by the *Network Service Provider* in relation to the conduct of the tests.

(d) Tests conducted under clause 4.1.6 must be conducted in accordance with test procedures agreed between the *Network Service Provider* and the relevant *Generator*. A *Generator* must not unreasonably withhold its agreement to test procedures proposed for this purpose by the *Network Service Provider*.

(e) For *Generators* that have an obligation to provide a computer model in accordance with clause 3.3.11, the *Network Service Provider* must provide to a *Generator* test results and any analysis that indicates a need to revise that model, and the *Generator* must provide an update to the *generation* system model in accordance with the *generation* system model procedure developed by the *Network Service Provider*.

(f) For *Generators* for which clause 4.1.6(e) does not apply, the *Network Service Provider* must provide to a *Generator* such details of the analytic parameters of the model derived from the tests referred to in clause 4.1.6 for any of that *Generator*'s *generating units* as may reasonably be requested by the *Generator*.

4.1.7 *Power system* tests

(a) Tests conducted for the purpose of either verifying the magnitude of the *power transfer capability* of the *transmission or distribution system* or investigating *power system* performance must be coordinated and approved by the *Network Service Provider*.

(b) The tests described in clause 4.1.7(a) must be conducted, if considered necessary by the *Network Service Provider* or *AEMO*, whenever:

(1) a new *generating unit* or *facility* or a *transmission or distribution system* development is commissioned that is calculated or anticipated to alter substantially the *power transfer capability* through the *transmission or distribution system*;

(2) setting *changes* are made to any *turbine control system* and *excitation control system*, including *power system* stabilisers; or

(3) they are required to verify the performance of the *power system* or to validate computer models.

(c) Tests as described in clause 4.1.7(a) may be requested by *AEMO* or by a *User*. In either case, the *Network Service Provider* must conduct the tests unless it reasonably considers that the grounds for requesting the test are unreasonable.

(d) If the *Network Service Provider* is satisfied that tests as described in clause 4.1.7(a) are necessary, it must develop a proposed test procedure describing how the tests will be undertaken and identify any potential impacts on *Users* during the tests. The test procedure should be finalised through consultation with affected *Users* and *AEMO* and published by the *Network Service Provider* at least 2 *months* before the start of any test.

(e) The *Network Service Provider* must notify all *Users* who could reasonably be expected to be affected by the proposed test at least 15 *business days* before any test under this clause 4.1.7 may proceed and consider any requirements of those *Users* when approving the proposed test.

(f) Operational conditions for each test must be arranged by the *Network Service Provider* in consultation, where relevant, with *AEMO*, and the test procedures must be coordinated by an officer nominated by the *Network Service Provider* who has authority to stop the test or any part of it or vary the procedure within pre-approved guidelines if it considers any of these actions to be reasonably necessary.

(g) A *User* must cooperate with the *Network Service Provider* when required in planning and conducting *transmission and distribution system* tests as described in clause 4.1.7(a).

(h) The *Network Service Provider*, following consultation where appropriate with *AEMO*, may direct the operation of *generating units* by *Users* during *power system* tests and, where necessary, the disconnection of *generating units* from the *transmission and distribution systems*, if this is necessary to achieve operational conditions on the *transmission and distribution systems* which are reasonably required to achieve valid test results.

(i) The *Network Service Provider* must plan the timing of tests so that the variation from *commitment* and *dispatch* that would otherwise occur is minimised and the duration of the tests is as short as possible consistent with test requirements and *power system security*.

(j) If a test conducted in accordance with this clause 4.1.7 identifies the need to revise computer models for *generating systems*:

(1) For *Generators* that have an obligation to provide a computer model in accordance with clause 3.3.11, the *Network Service Provider* must provide to a *Generator* test results and any analysis that indicates a need to revise that model, and the *Generator* must provide an update to the *generation* system model in accordance with the *generation* system model procedure developed by the *Network Service Provider*.

(2) For *generating systems* for which clause 4.1.7(j)(1) does not apply, the *Network Service Provider* must develop appropriate model revisions and provide revised models to the *Generator* if requested to do so.

4.1.8 *Provision of information*

(a) The *Network Service Provider* may request information from *Users* to validate the capacity and technical specification of equipment *connected* within the *User's facility*. The information that can be requested is limited to:

(1) information required to assess the impact of a *User's facility* on *power system security, power system reliability* or the *quality of supply* to other *Users,* and

(2) information required to assess the ability of the *facility* to meet the technical requirements specified in a *generator performance standard* or *connection agreement*.

(b) Information gathered by the *Network Service Provider* under this clause may be shared with *AEMO.*

(c) The *User* must use reasonable endeavours to provide the information requested by the *Network Service Provider* under this clause 4.1.8.

4.2 COMMISSIONING OF USER'S EQUIPMENT

4.2.1 Requirement to inspect and test equipment

(a) A *User* must ensure that new or replacement equipment is inspected and tested to demonstrate that it complies with relevant *Australian Standards*, relevant international standards, these *Rules*, the *Access Code* and any relevant *connection agreement* and *good electricity industry practice* prior to being *connected* to a *transmission or distribution system*.

(b) If a *User* installs or replaces equipment at a *connection point*, the *Network Service Provider* is entitled to witness the inspections and tests described in clause 4.2.1(a).

4.2.2 Co-ordination during commissioning

(a) A *User* seeking to connect equipment to a *transmission or distribution system* must cooperate with the *Network Service Provider* to develop procedures to ensure that the commissioning of the *connection* and *connected facility* is carried out in a manner that:

(1) does not adversely affect other *Users* or affect *power system security* or *quality of supply* to other *Users* of the *power system*; and

(2) minimises the threat of damage to the *Network Service Provider's* or any other *User's* equipment.

(b) A *User* may request the *Network Service Provider* schedule commissioning and tests (including the relevant exchange of correspondence) at particular times that suit the project completion dates. *The Network Service Provider* must make all reasonable efforts to accommodate such a request.

(c) A *User* must not connect equipment to the network without the approval of the *Network Service Provider* who must not approve such connection before the *User's* installation has been certified for compliance with these *Rules* and the *WA Electrical Requirements.* However, this clause 4.2.2(c) does not apply if clause 3.8 applies.

(d) Clauses 4.2.2(e) through 4.2.2(m) apply to *Generators* that operate *large generating systems* that are not *transmission connected market generators*.

> **Note:**
> The intention of this clause is to exclude subsequent clauses from applying to *large generating systems* that are covered by equivalent clauses in the *WEM Rules.*

(e) A *Generator* must not generate electricity unless it is doing so in accordance with a commissioning procedure agreed with the *Network Service Provider*, has a valid *interim approval to operate* (with or without conditions) or an *approval to operate*.

(f) The *Network Service Provider* may only issue an *interim approval to operate* without conditions to a *Generator* where the *Network Service Provider* and *AEMO* consider the relevant *large generating system* has not demonstrated any non-compliance based on observed performance with the applicable *registered generator performance standard* and there are no observed risks to *power system security* or *power system reliability*.

(g) Subject to clause 4.2.2(h), the *Network Service Provider* may, in its discretion and after consulting with *AEMO*:

(1) issue an *interim approval to operate* with conditions to a *Generator*; or

(2) place conditions on an *interim approval to operate* issued pursuant to clause 4.2.2(f).

(h) The *Network Service Provider* may only issue and place conditions on an *interim approval to operate* pursuant to clause 4.2.2(g) if after consulting with *AEMO* the *Network Service Provider*:

(1) either:

(A) does not consider the *large generating system* is demonstrating compliance based on observed performance with the applicable *registered generator performance standards*; or

(B) considers that conditions are required to mitigate any observed risks to *power system security* or *power system reliability*; and

(2) considers the *large generating system* is reasonably likely to resolve the performance issue and be compliant with the applicable *registered generator performance standards* in the future.

(i) Prior to being issued an *approval to operate*, if a *large generating system* is not meeting the applicable *registered generator performance standards*, the *Generator* responsible for the *large generating system* must:

(1) immediately notify the *Network Service Provider* and provide details of the non-compliance; and

(2) either:

(A) make any modification required to comply with the conditions and meet the applicable *registered generator performance standards* within the timeframe specified by the *Network Service Provider* or, if a *rectification plan* is required pursuant to clause 4.1.3(c), within the timeframe specified in the approved *rectification plan*; or

(B) as soon as practicable request to renegotiate any applicable *registered generator performance standards* it is unable to meet in which case clause 4.2.2(k) applies.

(j) Where the *Network Service Provider* is notified pursuant to clause 4.2.2(i)(1) , the *Network Service Provider* must advise *AEMO* as soon as reasonably practicable. The *Network Service Provider* may require the *Generator* to submit a *rectification plan* for approval in accordance with clause 4.1.3(c).

(k) The *Network Service Provider* may, in its discretion and with the approval of *AEMO*, agree to a request made pursuant to clause 4.2.2(i)(2)(B) to renegotiate a *registered generator performance standard* for a *generating system* where the *Network Service Provider* and *AEMO* agree the *Generator* will be able to meet and comply with an alternative *generator performance standard* that meets the applicable criteria listed in clause 3.3.4.2(b), in which case the process for consideration and approval of *proposed generator performance standards* in clause 3.3.4 applies.

(l) If the *Network Service Provider* refuses a request made pursuant to clause 4.2.2(i)(2)(B) to renegotiate a *registered generator performance standard* for a *large generating system* or an alternative *generator performance standard* cannot be agreed between the *Network Service Provider*, *AEMO* and the *Generator*, the *Generator* must comply with the applicable *registered generator performance standards* previously approved as recorded in the *register of performance requirements* within the timeframe specified by the *Network Service Provider*.

(m) The *Network Service Provider* may revoke an *interim approval to operate* issued pursuant to clause 4.2.2(f) or clause 4.2.2(g) , where the *Network Service Provider* reasonably considers that:

(1) the performance of the *large generating system* differs from the applicable *registered generator performance standards*; or

(2) the conditions placed on an *interim approval to operate* have not been met or complied with,

and the *Generator* responsible for the *large generating system* has not complied with the requirement in clause 4.2.2(i)(2).

(n) The *Network Service Provider* may consult with *AEMO* prior to making a decision under clause 4.2.2(m)

(o) The *Network Service Provider* must, after consulting with *AEMO*, issue an *approval to operate* to a *Generator* responsible for a *large generating system* where:

(1) a compliance program for the *large generating system* has been agreed with the Network Service Provided under clause 4.1.3(b) and the *Network Service Provider* has included it in the register of performance requirements;

(2) the operational performance of the *large generating system* is considered satisfactory to the *Network Service Provider* and *AEMO*; and

(3) the *Network Service Provider* considers the *Generator* responsible for the *large generating system* has met the requirements of, and indicated compliance with, the applicable *registered generator performance standards*.

4.2.3 Control and *protection* settings for equipment

(a) Not less than 65 *business days* (or as otherwise agreed between the *User* and the *Network Service Provider*) prior to the proposed commencement of commissioning by a *User* of any new or replacement equipment that could reasonably be expected to alter materially the performance of the *power system*, the *User* must submit to the *Network Service Provider* sufficient design information including proposed parameter settings to allow critical assessment including analytical modelling of the effect of the new or replacement equipment on the performance of the *power system*.

(b) The *Network Service Provider* must:

(1) consult with other *Users* and *AEMO* as appropriate; and

(2) within 20 *business days* of receipt of the design information under clause 4.2.3(a), notify the *User* of any comments on the proposed parameter settings for the new or replacement equipment.

(c) If the *Network Service Provider's* comments include alternative parameter settings for the new or replacement equipment, then the *User* must notify the *Network Service*

Provider within 10 *business days* that it either accepts or disagrees with the alternative parameter settings suggested by the *Network Service Provider*.

(d) The *Network Service Provider* and the *User* must negotiate parameter settings that are acceptable to them both and if there is any unresolved disagreement between them, the matter must be determined by means of the disputes procedure provided for in clause 1.7.

(e) The *User* and the *Network Service Provider* must co-operate with each other to ensure that adequate grading of *protection* is achieved so that faults within the *User's facility* are cleared without adverse effects on the *power system*.

4.2.4 Commissioning program

(a) Not less than 65 *business days* (or as otherwise agreed between the *User* and the *Network Service Provider*) prior to the proposed commencement of commissioning by a *User* of any new or replacement equipment that could reasonably be expected to alter materially the performance of the *power system*, the *User* must advise the *Network Service Provider* in writing of the commissioning program including test procedures and proposed test equipment to be used in the commissioning.

(b) The *Network Service Provider* must, within 20 *business days* of receipt of such advice under clause 4.2.4(a), notify the *User* either that it:

(1) agrees with the proposed commissioning program and test procedures; or

(2) requires changes in the interest of maintaining *power system security*, safety or *quality of supply*.

(c) If the *Network Service Provider* requires *changes*, then the *Network Service Provider* and the *User* must co-operate to reach agreement and finalise the commissioning program within a reasonable period.

(d) A *User* must not commence the commissioning until the commissioning program has been finalised and the *Network Service Provider* must not unreasonably delay finalising a commissioning program.

4.2.5 Commissioning tests

(a) The *Network Service Provider* and *AEMO* have the right to witness commissioning tests relating to new or replacement equipment, including *remote monitoring equipment*, *protection* and control and data acquisition equipment, that could reasonably be expected to alter materially the performance of the *power system* or the accurate metering of *energy* or be required for the real time operation of the *power system*.

(b) Prior to *connection* to the *transmission or distribution system* of new or replacement equipment covered by clause 4.2.5(a), a *User* must provide to the *Network Service*

Provider a signed written statement to certify that the inspection and tests required under clause 4.2.1(a) have been completed and that the equipment is ready to be *connected* and *energised*. The statement must be certified by a chartered professional engineer with National Engineering Register standing qualified in a relevant discipline.

(c) The *Network Service Provider* must, within a reasonable period of receiving advice of commissioning tests of a *User's* new or replacement equipment under this clause 4.2.5, advise the *User* whether or not it:

(1) wishes to witness the commissioning tests; and

(2) agrees with the proposed commissioning times.

(d) A *User* whose new or replacement equipment is tested under this clause 4.2.5 must, as soon as practicable after the completion of the relevant tests, submit to the *Network Service Provider* the commissioning test results demonstrating that a new or replacement item of equipment complies with these *Rules* or the relevant *connection agreement* or both to the satisfaction of the *Network Service Provider*.

(e) If the commissioning tests conducted under this clause 4.2.5 in relation to a *User's* new or replacement item of equipment demonstrate non-compliance with one or more requirements of these *Rules* or the relevant *connection agreement*, then the *User* must promptly meet with the *Network Service Provider* to agree on a process aimed at achieving compliance with the relevant item in these *Rules*.

(f) The *Network Service Provider* may direct that the commissioning and subsequent *connection* of a *User's* equipment must not proceed if the relevant equipment does not meet the technical requirements specified in clause 4.2.

(g) All commissioning tests under this clause 4.2.5 must be carried out under the supervision of personnel experienced in the commissioning of *power system primary equipment* and *secondary equipment*.

(h) The *Network Service Provider* must include the commissioning test results in the register of performance requirements defined in clause 3.2.6 .

4.2.6 Coordination of *protection* settings

(a) A *User* must ensure that its *protection* settings coordinate with the existing *protection* settings of the *transmission and distribution system*. Where this is not possible, the *User* may propose revised *protection* settings, for the *transmission and distribution system* to the *Network Services Provider*. In extreme situations it may be necessary for a *User* to propose a commercial arrangement to the *Network Service Provider* to modify the *transmission or distribution system protection*. The *Network Service Provider* must consider all such proposals, but it must not approve a *User's protection system* until *protection* coordination problems have been resolved. In some situations, the *User* may be required to revise the *Network Service Provider* settings or upgrade the *Network Service Provider's* or other *Users*' equipment, or both.

(b) If a *User* seeks approval from the *Network Service Provider* to apply or *change* a control or *protection system* setting, this approval must not be withheld unless the *Network Service Provider* reasonably determines that the changed setting would cause the *User* not to comply with the requirements of Chapter 3 of these *Rules*, or the *power system* not to comply with the performance standards specified in clause 2.2, or the *Network Service Provider* or some other *User* not to comply with their own *protection* requirements specified in the respective clauses 2.9 and 3.5, or the *power transfer capability* of the *transmission or distribution system* to be reduced.

(c) If the *Network Service Provider* reasonably determines that a setting of a *User's control system* or *protection system* needs to *change* in order for the *User* to comply with the requirements of Chapter 3 of these *Rules*, or for the *power system* to meet the performance standards specified in clause 2.2 or so as not to cause the *Network Service Provider* or some other *User* to fail to comply with its own *protection* requirements specified in clause 2.9 or 3.5, as applicable, or for the *power transfer capability* of the *transmission or distribution system* to be restored, the *Network Service Provider* must consult with the *User* and may direct in writing that a setting be applied in accordance with the determination.

(d) The *Network Service Provider* may require a test in accordance with clause 4.1.3 to verify the performance of the *User's* equipment with any new setting.

4.2.7 Approval of proposed *protection*

(a) A *User* must not allow its plant to take *supply* of electricity from the *power system* without prior approval of the *Network Service Provider*.

(b) A *User* must not *change* the approved *protection* design or settings without prior written approval of the *Network Service Provider.*

4.3 DISCONNECTION AND RECONNECTION

4.3.1 General

(a) If the *Network Service Provider*, in its opinion, needs to interrupt *supply* to any *User* of the *transmission system* for reasons of safety to the public, the *Network Service Provider's* personnel, any *Users*' equipment or the *Network Service Provider's* equipment, the *Network Service Provider* must (time permitting) consult with the relevant *User* prior to executing that interruption. Such consultations are generally impracticable at the *distribution system* level, because of the large number of *Users* involved, and hence are not required in relation to interruptions to *supply* to *Users* on the *distribution system*.

(b) The *Network Service Provider* may *disconnect Users* if the *transmission or distribution system* is operating outside the permissible limits.

4.3.2 Voluntary *disconnection*

(a) Unless agreed otherwise and specified in a *connection agreement*, a *User* must give to the *Network Service Provider* notice in writing of its intention to *disconnect* a *facility* permanently from a *connection point*.

(b) A *User* is entitled, subject to the terms of the relevant *connection agreement*, to require voluntary permanent disconnection of its equipment from the *power system*, in which case appropriate operating procedures necessary to ensure that the disconnection will not threaten *power system security* must be implemented in accordance with clause 4.3.3.

4.3.3 *Disconnection* procedures

(a) If a *User's facility* is to be *disconnected* permanently from the *power system*, whether in accordance with clause 4.3.2 or otherwise, the *Network Service Provider* and the *User* must, prior to such disconnection occurring, follow agreed procedures for disconnection.

(b) The *Network Service Provider* must notify other *Users* if it reasonably believes that their rights under a *connection agreement* will be adversely affected by the implementation of the procedures for disconnection agreed under clause 4.3.3(a). The *Network Service Provider* and the *User* and, where applicable, other affected *Users* must negotiate any amendments to the procedures for disconnection or the relevant *connection agreements* that may be required.

(c) Any disconnection procedures agreed to or determined under clause 4.3.3(a) must be followed by the *Network Service Provider* and all relevant *Users*.

4.3.4 Involuntary *disconnection*

(a) The *Network Service Provider* or *AEMO* may *disconnect* a *User's facilities* from the *transmission or distribution system* or otherwise curtail the provision of services in respect of a *connection point*:

(1) in the case of the *Network Service Provider*, where directed to do so by *AEMO* in the exercise or purported exercise of a power under the *WEM Rules*;

(2) in accordance with clause 4.1.3(n);

(3) in accordance with clause 4.3.5;

(4) during an emergency in accordance with clause 4.3.6;

(5) for safety reasons where the *Network Service Provider* considers that the connection of the *User's facilities* may create a serious hazard to people or property;

(6) in accordance with the provisions of any *written law*; or

(7) in accordance with any *connection agreement* relating to the *connection point*.

> **Note:**
> Disconnection in accordance with clause 4.3.4(a)(5) could occur, for example, if the *Network Service Provider* becomes aware that a *User's* earthing arrangements have been *changed* to the extent that they may no longer meet the requirements of clause 3.4.8(e).

(b) In all cases of *disconnection* by the *Network Service Provider* during an emergency in accordance with clause 4.3.6 the *Network Service Provider* must provide a report to the *User* advising of the circumstances requiring such action.

4.3.5 Curtailment to undertake works

(a) The *Network Service Provider* may, in accordance with *good electricity industry practice*, *disconnect* a *User's facilities* from the *transmission or distribution system* or otherwise curtail the provision of services in respect of a *connection point* (collectively in this clause 4.3.5 a "curtailment"):

(1) to carry out planned *augmentation* or maintenance to the *transmission or distribution system*; or

(2) to carry out unplanned maintenance to the *transmission or distribution system* where *the Network Service Provider* considers it necessary to do so to avoid injury to any person or material damage to any property or the environment; or

(3) if there is a breakdown of, or damage to, the *transmission or distribution system* that affects *the Network Service Provider's* ability to provide services at that *connection point*; or

(4) if an event:

(A) that is outside the reasonable control of the *Network Service Provider*; and

(B) whose effect on the assets of the *Network Service Provider* or the property of any person cannot, by employing *good electricity industry practice*, be prevented,

is imminent, with the result that safety requirements or the need to protect the assets of the *Network Service Provider* or any other property so require; or

(5) to the extent necessary for *the Network Service Provider* to comply with a *written law*.

(b) *The Network Service Provider* must keep the extent and duration of any curtailment under clause 4.3.5(a) to the minimum reasonably required in accordance with *good electricity industry practice.*

(c) *The Network Service Provider* must notify each *User* of the *transmission system* who will or may be adversely affected by any proposed curtailment under clause 4.3.5(a) of that proposed curtailment as soon as practicable. Where it is not reasonably practicable to notify a *User* prior to the commencement of the curtailment, the *Network Service Provider* must do so as soon as reasonably practicable after its commencement.

(d) If *the Network Service Provider* notifies a *User* of a curtailment in accordance with clause 4.3.5(c) in respect of a *connection point*, the *User* (acting reasonably and prudently) must comply with any requirements set out in the notice concerning the curtailment.

4.3.6 ***Disconnection*** **during an emergency**

Where the *Network Service Provider* or *AEMO* is of the opinion that it must *disconnect* a *User's facilities* during an emergency under these *Rules* or otherwise, then the *Network Service Provider* or *AEMO*, as applicable, may:

(a) request the relevant *User* to reduce the *power transfer* at the proposed point of disconnection to zero in an orderly manner and then *disconnect* the *User's facility* by automatic or manual means; or

(b) immediately *disconnect* the *User's facilities* by automatic or manual means where, in the opinion of the *Network Service Provider* or *AEMO*, as applicable, it is not appropriate to follow the procedure set out in clause 4.3.6(a) because action is urgently required as a result of a threat to safety of persons, hazard to equipment or a threat to *power system security*.

4.3.7 Obligation to reconnect

The *Network Service Provider* must reconnect a *User's facilities* to a *transmission or distribution system* as soon as practicable:

(a) in the case of the *Network Service Provider*, where directed to do so by *AEMO* in the exercise or purported exercise of a power under the *WEM Rules*;

(b) if the breach of the *Access Code*, these *Rules* or a *connection agreement* giving rise to the disconnection has been remedied; or

(c) if the *User* has taken all necessary steps to prevent the re-occurrence of the relevant breach and has delivered binding undertakings to the *Network Service Provider* or *AEMO*, as applicable, that the breach will not re-occur.

5. *TRANSMISSION AND DISTRIBUTION SYSTEM OPERATION AND COORDINATION*

5.1 APPLICATION

This Chapter 5 applies to the operation and coordination of the *Network Service Provider's* and *Users*' *facilities* to the extent not covered under the *WEM Rules*. For Market Participants (as defined under the *WEM Rules*) the rules that apply for *power system* operation and coordination are those found within the *WEM Rules*.

Chapter 5 does not explicitly define the requirements for operational coordination between the *Network Service Provider* and *AEMO* as those requirements are described in the *WEM Rules* and associated procedures.

> **Note:**
> In this chapter, references to *AEMO's* direct control refer to the sections of the *transmission system* where *AEMO* is responsible for *power system security* and *power system reliability*.

5.2 INTRODUCTION

5.2.1 Purpose and Scope of Chapter 5

(a) This Chapter 5, which applies to, and defines obligations for, the *Network Service Provider* and all *Users*, has the following aims:

(1) to establish processes and arrangements to enable the *Network Service Provider* to plan and conduct operations within the *power system*;

(2) to establish arrangements for the actual *dispatch* of *generating units* and *loads* by *Users*, and

(3) to define operational criteria that the *Network Service Provider* endeavours to meet when planning and operating the *power system*.

(b) The *Network Service Provider's* operational obligations and responsibilities are classified as *Transmission Network Operator* or *Distribution Network Operator* obligations and responsibilities.

5.3 POWER SYSTEM OPERATION CO-ORDINATION RESPONSIBILITIES AND OBLIGATIONS

5.3.1 Responsibilities of the *Transmission Network Operator*

(a) The *Transmission Network Operator*'s responsibilities for the operation and co-ordination of the *transmission system* are to:

(1) take steps to coordinate switching procedures and arrangements in accordance with *good electricity industry practice* in order to avoid damage to equipment, to ensure the safety of the *power system,* and maintain *power system reliability, transmission network adequacy* and *power system security*;

(2) operate all equipment under its control or co-ordination within the appropriate operational or emergency limits which are either established by the *Network Service Provider* or advised by the respective *Users*;

(3) assess the impacts of any technical and operational limitations of all plant and equipment *connected* to the *transmission system* on the operation of the *power system*;

(4) subject to clause 5.3.1(a)(7):

(A) *disconnect Users'* equipment, or

(B) require a *User* to operate its equipment,

as necessary to maintain and restore secure and reliable operation of the *power system*;

(5) coordinate and direct any rotation of *supply* interruptions in the event of a major *supply* shortfall or disruption;

(6) investigate and review all major *transmission system* and *power system* operational incidents and to initiate action plans to manage any abnormal situations or significant deficiencies that could reasonably threaten safe and reliable operation of the *transmission system*. Such situations or deficiencies include:

(A) *power system frequencies* outside those specified in the *frequency operating standards* specified in the *WEM Rules* and investigation or review is required to support an *AEMO* investigation under the *WEM Rules*;

(B) *power system voltages* outside those specified in clause 2.2.2;

(C) actual or potential lack of *power system stability*;

(D) unplanned or unexpected operation of *power system* equipment;

(7) operate those parts of the *transmission system* that are not under the control of *AEMO* so as to ensure that the *power system* performance standards as specified in clause 2.2 are met; and

(8) operate the *transmission system* in accordance with the operational criteria specified in clause 5.4.1.

(b) The operational activities performed by the *Transmission Network Operator* must be coordinated with *AEMO* following the processes defined in the *WEM Rules* and further informed by the relevant operating protocol established in accordance with clause 3.1A of the *WEM Rules*.

5.3.2 Responsibilities of the *Distribution Network Operator*

(a) The *Distribution Network Operator*'s responsibilities for the operation and co-ordination of the *distribution system* are to:

(1) take steps to coordinate switching procedures and arrangements in accordance with *good electricity industry practice* in order to avoid damage to equipment, to ensure the safety of the *power system,* and maintain *power system reliability, transmission network adequacy* and *power system security*;

(2) operate all equipment under its control or co-ordination within the appropriate operational or emergency limits which are either established by the *Network Service Provider* or advised by the respective *Users*;

(3) assess the impacts of any technical and operational limitations of all plant and equipment *connected* to the *distribution system* on the operation of the *power system*;

(4) subject to clause 5.3.2(a)(7):

(A) disconnect *Users'* equipment; or

(B) require a *User* to operate its equipment,

as necessary to maintain and restore secure and reliable operation of the *power system*;

(5) coordinate and direct any rotation of *supply* interruptions in the event of a major *supply* shortfall or disruption;

(6) investigate and review all major *distribution system* and *power system* operational incidents and to initiate action plans to manage any abnormal situations or significant deficiencies that could reasonably threaten safe and reliable operation of the *distribution system*. Such situations or deficiencies include:

(A) *power system frequencies* outside those specified in the *frequency operating standards* specified in the *WEM Rules* and investigation or review is required to support an *AEMO* investigation under the *WEM Rules*;

(B) *power system voltages* outside those specified in clause 2.2.3;

(C) actual or potential lack of *power system stability*;

(D) unplanned or unexpected operation of *power system* equipment;

(7) operate those parts of the *distribution system* that are not under the control of *AEMO* so as to ensure that the *power system* performance standards as specified in clause 2.2 are met; and

(b) the operational activities impacting *power system security* performed by the *Distribution Network Operator* must be coordinated with *AEMO* as informed by the relevant operating protocol established in accordance with clause 3.1A of the *WEM Rules*.

5.3.3 *User* obligations

(a) A *User* must ensure that only appropriately qualified and competent persons operate equipment that is directly *connected* to the *transmission or distribution system* through a *connection point*.

(b) A *User* must co-operate with any review of operating incidents undertaken by the *Transmission Network Operator* under clause 5.4.4.3, or the *Distribution Network Operator* under clause 5.5.3.3.

(c) A *User* must co-operate with and assist the *Transmission Network Operator* and the *Distribution Network Operator* in the proper discharge of the *transmission or distribution system* operation and co-ordination responsibilities.

(d) A *User* must operate its *facilities* and equipment in accordance with any *direction* given by the *Transmission Network Operator, Distribution Network Operator* or *AEMO*.

(e) A *User* must notify *AEMO* or, where appropriate, the *Transmission Network Operator* or *Distribution Network Operator,* prior to a *generating unit* being operated in a mode (e.g. “turbine-follow” mode) where the *generating unit* will be unable to respond in accordance with the technical requirements specified in clause 3.3.7.6.

(f) Except in an emergency, a *User* must notify the *Transmission Network Operator* at least 5 *business days* prior to taking a *protection* of *transmission element* out of service in accordance with availability requirements specified in clause 2.9.3.

(g) Except in an emergency, a *User* must notify the *Distribution Network Operator* at least 5 *business days* prior to taking a *protection* of *distribution element* out of service if this *protection* is required to meet a *critical fault clearance time* in accordance with availability requirements specified in clause 2.9.3.

(h) A *User* must operate their *facilities* in accordance with any relevant *User Operating Protocol* negotiated with the *Network Service Provider* in accordance with clause 5.7.2.

5.4 TRANSMISSION NETWORK OPERATOR DETAILED OBLIGATIONS

5.4.1 Operational criteria for the *transmission system*

5.4.1.1 General

(a) The *Transmission Network Operator* must:

(1) operate the *transmission* network in accordance with the *power system security* requirements specified in clauses 5.3.1(b) and 5.4.1.2;

(2) in accordance with the *WEM Rules,* follow *directions* issued by *AEMO* to maintain *power system security* or *power system reliability*.

5.4.1.2 *Power system security* requirements

(a) The *transmission system* shall be operated under *prevailing system conditions* with no:

(1) equipment loadings exceeding *pre-fault ratings* or *unacceptable overloading*;

(2) *unacceptable voltage conditions*, or

(3) *system instability;*

(b) Subject to clause 5.4.1.2(a), the *transmission system* shall be operated such that for the *credible contingency* of a *fault outage* on the *transmission system* of any of the following:

(1) a single *transmission circuit;*

(2) a *zone substation transformer*;

(3) a *reactive equipment*;

(4) a single *generation circuit*;

(5) a single *generating unit* (or several *generating units* sharing a common circuit breaker),

there must be no:

(6) *loss of demand* except as specified in Table 2-10;

(7) *unacceptable overloading* of any *transmission equipment*;

(8) *unacceptable voltage conditions*; or

(9) *system instability*.

(c) Subject to clause 5.4.1.2(a), the *transmission system* shall also be operated such that for any other *contingency* deemed credible by *AEMO* in *operational timescales*, there must be no:

(1) *unacceptable overloading* of any *transmission equipment*;

(2) *unacceptable voltage conditions*; or

(3) *system instability*.

(d) Where the *Network Service Provider* identifies a compliance violation with the requirements under clauses 5.4.1.2(a), 5.4.1.2(b), and 5.4.1.2(c), then they must, in consultation with *AEMO*, alter the *prevailing system conditions* within its control capability as soon as practicable to bring the *power system* back into compliance with these clauses.

Note:
For clarity, the above clauses are not intended to alter the obligation on the *Network Service Provider* to take all practical steps to minimise *load* loss during operation. *AEMO* is responsible for managing *essential system services* in accordance with the *WEM Rules*. Any shortfalls in *essential system services* will be managed by *AEMO*.

5.4.2 ***Transmission system voltage* control**

(a) The *Transmission Network Operator* must monitor the adequacy of the capacity to produce or absorb *reactive power* to control the *transmission system voltages* within the operational *voltage* envelope specified by *AEMO*.

(b) The *Transmission Network Operator* must monitor *voltages* on the *transmission system* and implement operational arrangements to maintain *voltages* within the operational *voltage* envelope specified by *AEMO* and the *voltage* limits specified in clause 2.2.

(c) Operational arrangements implemented to control *voltage* may include any combination of the following:

(1) operating *transmission equipment*;

(2) requiring *Users* to operate their *facilities* to provide a level of *voltage* support consistent with the relevant technical requirements documented in the *connection agreement* or the 'User Performance Register' defined in clause 3.2.6; or

(3) utilising additional services procured through contractual arrangements with *Users*.

5.4.3 **Partial *outage* of *transmission system protection systems***

(a) Where there is an *outage* of one *protection scheme* of a *transmission element*, the *Transmission Network Operator* must determine, and where appropriate advise *AEMO* of, the most appropriate action to take to deal with that *outage*. Depending on the circumstances, the determination may be:

(1) to leave the *transmission element* in service for a limited duration;

(2) to take the *transmission element* out of service immediately;

(3) to install or direct the installation of a temporary *protection scheme*;

(4) to accept a degraded performance from the *protection system*, with additional operational measures or other temporary measures to minimise *power system* impact where deemed necessary; or

(5) to operate the *transmission element* at a lower capacity.

(b) If there is an outage of both protections on a *transmission element* and the *Transmission Network Operator* determines that to leave the *transmission element* in service presents an unacceptable risk to *power system* security, the *Transmission Network Operator* must take the *transmission element* out of service as soon as practicable and advise *AEMO* and any affected *Users* immediately this action is undertaken.

(c) The *Transmission Network Operator* must abide by any relevant instruction given to it by *AEMO* in accordance with the *WEM Rules*.

(d) When assessing the impact of *transmission equipment protection outages* in accordance with this clause 5.4.3, the *Transmission Network Operator* must consider the availability requirements specified in the *transmission protection* requirements in clause 2.9.3.

5.4.4 *Transmission system* operation and co-ordination

5.4.4.1 Response to *User's* advice

If the *Transmission Network Operator* considers the circumstances advised to it under clause 5.6.2.1(a) to be a threat to *power system security*, the *Transmission Network Operator,* in consultation as necessary with *AEMO*, may *direct* that the equipment protected or operated by the relevant *protection* or *control system* be taken out of operation or operated in such manner as the *Transmission Network Operator* requires.

5.4.4.2 Managing electricity *supply* shortfall events

Note:
It is the responsibility of *AEMO* under the *WEM Rules* to manage *supply* shortfall events arising from a shortage of *generation* or from multiple *contingency events* on those parts of the *transmission system* under its direct control. However, *supply* shortfall events may also occur as a result of *contingency events* arising within those parts of the *transmission and distribution systems* under the control of the *Network Service Provider.* In addition, the *Transmission Network Operator* may be required to manage the rotation of *supply* interruptions in accordance with clause 5.3.1(a)(5).

(a) If, at any time, there are insufficient *transmission or distribution system supply* options available to *supply* total *load* in a *region* securely, then the *Transmission Network Operator* may undertake any one or more of the following:

(1) recall of a *transmission equipment* outage where the item of *transmission equipment* is not under the direct control of *AEMO*;

(2) disconnect one or more *load connection points* as:

(A) the *Transmission Network Operator* considers necessary in accordance with procedures under the *WEM Rules*; or

(B) directed by *AEMO* in accordance with the demand control measures in the *WEM Rules*; or

(3) *direct* a *User* to take such steps as are reasonable to reduce its *load* immediately. Any temporary *load* reduction must be such that preference in *supply* is given, where necessary, to domestic consumers, then commercial consumers and finally industrial consumers.

(b) If there is a major *supply* shortfall, the *Transmission Network Operator* must implement, to the extent practicable, *load shedding* across interconnected *regions* in accordance with any relevant provisions under the *WEM Rules*.

5.4.4.3 Review of operating incidents

(a) The *Transmission Network Operator* may conduct reviews of significant operating incidents or deviations from normal operating conditions in order to assess the adequacy of the provision and response of *facilities* or services, and must do so if directed by *AEMO*.

(b) For cases where the *Transmission Network Operator* has disconnected a *transmission system User*, a report must be provided by the *Transmission Network Operator* to the *User* detailing the circumstances that required the *Transmission Network Operator* to take that action.

(c) The *Transmission Network Operator* must provide to a *User* available information or reports, as is reasonable, relating to the performance of that *User's* equipment during *power system* incidents or operating condition deviations following a *User's* request.

5.4.5 *Transmission system* operations and maintenance planning

(a) The *Transmission Network Operator* must develop an *outage* assessment guideline to guide a consistent application of the risk-based *outage* assessment process.

(b) The *Transmission Network Operator* must assess the potential impact of proposed *outages* of *transmission equipment* using the risk-based assessment process described in the outage assessment guideline.

(c) The risk-based *outage* assessment process should ensure that the timing of *outages* of *transmission equipment* and arrangements implemented to facilitate those *outages*:

(1) are consistent with the *transmission system planning criteria* defined in section 2.5;

(2) enable the operational criteria defined in section 5.4.1 to be achieved; and

(3) appropriately balance the measures necessary to facilitate taking the *outage* against any risks to safety, security and the reliability of the *transmission system* from using those measures.

(d) Where required by the *WEM Rules,* the *Transmission Network Operator* must submit *transmission equipment outage* requests to *AEMO* for approval.

(e) When undertaking approved *outages* of *transmission* equipment, any relevant *User* arrangements made in accordance with clause 3.1(b) must be considered by the *Transmission Network Operator*.

5.5 *DISTRIBUTION NETWORK OPERATOR* DETAILED OBLIGATIONS

5.5.1 Operational criteria for the *distribution system*

(a) The *Distribution Network Operator* must:

(1) operate those parts of the *distribution system* not under the control of *AEMO* to meet the requirements in clauses 5.3.2(b) and 5.3.2(a)(7); and

(2) in accordance with the *WEM Rules,* follow *directions* issued by *AEMO* to maintain *power system security* or *power system reliability*.

5.5.2 *Distribution System voltage* control

(a) The *Distribution Network Operator* must determine the adequacy of the capacity to produce or absorb *reactive power* to control the *distribution system voltages*.

(b) The *Distribution Network Operator* must monitor *voltages* on the *distribution system* and implement operational arrangements to maintain *voltages* within the *voltage* limits specified in clause 2.2.

(c) Operational arrangements implemented to control *voltage* may include any combination of the following:

(1) Operating *distribution system* equipment;

(2) requiring *Users* to operate their *facilities* to provide a level of *voltage* support consistent with the relevant technical requirements documented

in the *connection agreement* or the 'User Performance Register' defined in clause 3.2.6; or

(3) utilising additional services procured through contractual arrangements with *Users*.

5.5.3 *Distribution system* operation and co-ordination

5.5.3.1 *Response to User's* advice

If the *Distribution Network Operator* considers the circumstances advised to it under clause 5.6.2.1(a) to be a threat to *power system security*, the *Distribution Network Operator*, in consultation where necessary with *AEMO,* may *direct* that the equipment protected or operated by the relevant *protection* or *control system* be taken out of operation or operated in such manner as the *Distribution Network Operator* requires.

5.5.3.2 Managing electricity *supply* shortfall events

Note:
It is the responsibility of *AEMO* under the *WEM Rules* to manage *supply* shortfall events arising from a shortage of *generation* or from multiple *contingency events* on those parts of the *transmission system* under its direct control. However, *supply* shortfall events may also occur as a result of *contingency events* arising within those parts of the *transmission and distribution systems* under the control of the *Network Service Provider.* In addition, the *Distribution Network Operator* may be required to manage the rotation of *supply* interruptions in accordance with clause 5.3.2(a)(5).

(a) If, at any time, there are insufficient *distribution supply* options available to *supply* total *load* securely, then the *Distribution Network Operator* may undertake any one or more of the following:

(1) recall of a *distribution equipment outage*;

(2) disconnect one or more *load connection points* as:

(A) the *Distribution Network Operator* considers necessary; or

(B) directed by *AEMO* in accordance with the demand control measures in the *WEM Rules*; or

(3) *direct* a *User* to take such steps as are reasonable to reduce its *load* immediately. Any temporary *load* reduction must be such that preference in *supply* is given, where necessary, to domestic consumers, then commercial consumers and finally industrial consumers.

(b) If there is a major *supply* shortfall, the *Distribution Network Operator* must implement, to the extent practicable, *load shedding* in accordance with any relevant provisions under the *WEM Rules*.

5.5.3.3 Review of operating incidents

(a) The *Distribution Network Operator* may conduct reviews of significant operating incidents or deviations from normal operating conditions in order to assess the adequacy of the provision and response of *facilities* or services, and must do so if directed by *AEMO*.

(b) Unless specifically included in the *connection agreement*, there is no requirement for the *Distribution Network Operator* to provide a report to a *distribution system User* that is disconnected by the *Distribution Network Operator* or *AEMO.* Where such a report is required, it must detail the circumstances that required the *Distribution Network Operator* or *AEMO* to disconnect the *User*.

(c) The *Distribution Network Operator* must provide to a *User* available information or reports, as is reasonable, relating to the performance of that *User's* equipment during *power system* incidents or operating condition deviations following a *User's* request.

5.5.4 *Distribution system* operations and maintenance planning

(a) The *Distribution Network Operator* must assess the potential impact of proposed *outages* of *distribution equipment.*

(b) Where required by the *WEM Rules,* the *Distribution Network Operator* must submit *distribution equipment outage* requests to *AEMO* for approval.

(c) When undertaking approved *outages* of *distribution* equipment, any relevant *User* arrangements made in accordance with clause 3.1(b) must be considered by the *Distribution Network Operator*.

5.6 USER DETAILED OBLIGATIONS

5.6.1 Partial *outage* of *transmission system protection systems*

A *User* must act consistently with determinations made by the *Network Service Provider* under clause 5.4.3.

5.6.2 Power system operation and co-ordination

5.6.2.1 *User's* advice

(a) A *User* must promptly advise the *Network Service Provider* if the *User* becomes aware of any circumstance, including any defect in, or mal-operation of, any *protection* or *control system*, which could be expected to adversely affect the secure operation of the *power system*.

(b) A *User* must comply with a *direction* given by the *Transmission Network Operator* under clause 5.4.4.1 or the *Distribution Network Operator* under clause 5.5.3.1.

5.6.2.2 Managing electricity *supply* shortfall events

A *User* must comply with a *direction* given under clause 5.4.4.2(a)(3) or clause 5.5.3.2(a)(3).

5.6.2.3 Review of operating incidents

(a) A *User* must co-operate in any review of operating incidents conducted by the *Network Service Provider* (including by making available relevant records and information) under clause 5.4.4.3 or clause 5.5.3.3.

(b) A *User* must provide to the *Network Service Provider* such information relating to the performance of its equipment during and after particular *power system* incidents or operating condition deviations as the *Network Service Provider* reasonably requires for the purposes of analysing or reporting on those *power system* incidents or operating condition deviations.

5.6.3 Operations and maintenance planning

> **Note:**
> This clause is not intended to apply to *Users* who are registered as Rule Participants under Section 2 of the *WEM Rules*. Outage planning for Rule Participants is undertaken by *AEMO* in accordance with clauses 3.18 to 3.21 of the *WEM Rules*.

In accordance with clause A3.56 of the *Access Code*, for coordination purposes, operation, maintenance and *extension* planning and co-ordination must be performed as follows:

(a) on or before 1 July and 1 January each year, a *User*, where so requested by the *Network Service Provider*, must provide to the *Network Service Provider*:

(1) a maintenance schedule in respect of the equipment and equipment *connected* at each of its *connection points* for the following *financial year*; and

(2) a non-binding indicative planned maintenance plan in respect of the equipment and equipment *connected* at each of its *connection points* for each of the 2 *financial years* following the *financial year* to which the maintenance schedule provided under clause 5.6.3(a)(1) relates.

(b) A *User* must provide the *Network Service Provider* with any information that the *Network Service Provider* requests concerning maintenance of equipment and equipment *connected* at the *User's connection points*.

(c) A *User* must ensure that a maintenance schedule provided by the *User* under clause 5.6.3(a)(1) is complied with, unless otherwise agreed with the *Network Service Provider*.

(d) Both a maintenance schedule and a maintenance plan must:

(1) specify the dates and duration of *planned outages* for the relevant equipment which may have an impact on the *transmission system*;

(2) specify the work to be carried out during each such an *outage*;

(3) be in writing in substantially the form requested by the *Network Service Provider*; and

(4) be consistent with *good electricity industry practice*.

(e) If a *User* becomes aware that a maintenance schedule provided by the *User* under clause 5.6.3(a)(1) in respect of one of its *connection points* will not be complied with, then the *User* must promptly notify the *Network Service Provider*.

5.7 POWER SYSTEM OPERATING PROCEDURES, PROTOCOLS, AUDITS AND INFORMATION

5.7.1 Operation of *User*'s equipment

(a) A *User* must observe the requirements of the relevant *power system operating procedures*.

(b) A *User* must operate its equipment interfacing with the *transmission or distribution system* in accordance with the requirements of the *Access Code*, these *Rules*, any applicable *connection agreement*, *User Operating Protocol*, and the *Network Service Provider's* electrical safety instructions and procedures.

(c) The *Network Service Provider* may *direct* a *User* to place *reactive power facilities* belonging to, or controlled by, that *User* into or out of service for the purposes of maintaining *power system* performance standards specified in clause 2.2. A *User* must comply with any such *direction*.

5.7.2 Operating protocols

(a) If required by the *Network Service Provider*, a *User* must cooperate with the *Network Service Provider* to develop a *User Operating Protocol* that captures operational arrangements for their *facility.*

(b) *User Operating Protocols* should be consistent with the template developed by the *Network Service Provider*.

(c) A *User* must negotiate any revisions to relevant *User Operating Protocols* to ensure the protocol continues to accurately record operating arrangements relevant to their *facility*.

5.7.3 *Power system* fault levels

(a) The *Network Service Provider* must determine the maximum prospective fault levels at all *transmission system busbars* and all *zone substation supply busbars*. This determination must consider all credible *transmission system* operating configurations and all credible *generation* patterns but need not consider short term switching arrangements that result in, for example, the temporary paralleling of *transformers* to maintain continuity of *supply*.

(b) The fault levels determined under clause 5.7.3(a) must be publicly available. In addition, the *Network Service Provider* must ensure that there is available to a *User*, on request, such other information as will allow the *User* to determine the maximum fault level at any of the *User's connection points*.

5.7.4 *Protection* audit and testing

The *Network Service Provider* must coordinate such inspections and tests as the *Network Service Provider* thinks appropriate to ensure that the *protection* of the *transmission and distribution system* is adequate to protect against damage to *equipment* and facilitate safe and secure operation of the *power system*. Such tests must be performed according to the requirements of clause 4.1.

5.7.5 Audit and testing of reactive power control equipment

The *Network Service Provider* must arrange, coordinate and supervise the conduct of appropriate tests to assess the availability and adequacy of the provision of *reactive power* devices to control and maintain *power system voltages*.

5.7.6 Audit and testing of *power system stability* systems

The *Network Service Provider* must arrange, coordinate and supervise the conduct of such inspections and tests as it deems appropriate to assess the availability and adequacy of the devices installed to maintain *power system stability*.

5.8 POWER SYSTEM OPERATION SUPPORT

5.8.1 Remote control and monitoring devices

(a) All remote control, operational metering and monitoring devices and local circuits as described in Chapter 3 must be installed, operated and maintained by a *User* in accordance with the standards and protocols determined and advised by the *Network Service Provider* or *AEMO*.

(b) The *Network Service Provider* must publish a 'Generating System Control and Monitoring Guideline', describing the signals that a *User* may need to monitor and make available to the *Network Service Provider* or *AEMO.* In developing the guideline, the *Network Service Provider* must consider the procedure developed in accordance with clause 2.35.4 of the *WEM Rules.*

5.8.2 *Power system operational communication facilities*

(a) *Users* must advise the *Network Service Provider* of its requirements for the giving and receiving of *operational communications* in relation to each of its *facilities* and ensure these are kept up to date. The requirements that must be forwarded to the *Network Service Provider* include:

(1) the title of contact position;

(2) the telephone numbers of that position;

(3) the telephone numbers of other available communication systems in relation to the relevant *facility*;

(4) a facsimile number for the relevant *facility*; and

(5) an electronic mail address for the relevant *facility*.

(b) A *User* must maintain the speech communication channel installed in accordance with clause 3.3.10(c) or clause 3.6.8(d) in good repair and must investigate any fault within 4 hours, or as otherwise agreed with the *Network Service Provider*, of that fault being identified and must repair or procure the repair of faults promptly.

(c) Where required by *AEMO* or the *Network Service Provider* a *User* must establish and maintain a form of electronic mail *facility* as approved by the *Network Service Provider* for communication purposes.

(d) The *Network Service Provider* must, where necessary for the operation of the *transmission and distribution system*, advise *Users* of nominated persons for the purposes of giving or receiving *operational communications* and ensure this is kept up to date.

(e) Contact details to be provided by the *Network Service Provider* in accordance with clause 5.8.2(d) include position, telephone numbers, a facsimile number and an electronic mail address.

5.8.3 Authority of nominated operational contacts

The *Network Service Provider* and a *User* are each entitled to rely upon any communications given by or to a contact designated under clause 5.8.2 as having been given by or to the *User* or the *Network Service Provider*, as the case requires.

5.8.4 Records of *power system operational communication*

(a) The *Network Service Provider* and *Users* must log each telephone *operational communication* in the form of entries in a log book which provides a permanent record as soon as practicable after making or receiving the *operational communication*.

(b) In addition to the log book entry required under clause 5.8.4(a), the *Network Service Provider* must make a voice recording of each telephone *operational communication.* The *Network Service Provider* must ensure that when a telephone conversation is being recorded under this clause 5.8.4(b), the persons having the conversation receive an audible indication that the conversation is being recorded in accordance with relevant statutory requirements.

(c) Records of *operational communications* must include the time and content of each communication and must identify the parties to each communication.

(d) The *Network Service Provider* and *Users* must retain all *operational communications* records including voice recordings for a minimum of 7 years.

(e) If there is a dispute involving an *operational communication*, the voice recordings of that *operational communication* maintained by, or on behalf of, the *Network Service Provider* will constitute prima facie evidence of the contents of the *operational communication*.

5.9 NOMENCLATURE STANDARDS

(a) A *User* must use the *nomenclature standards* for *transmission* and *distribution* equipment and apparatus as determined by the *Network Service Provider* and use the specified nomenclature in any *operational communications* with the *Network Service Provider*.

(b) A *User* must ensure that name plates on its equipment relevant to operations at any point within the *power system* conform to the specified *nomenclature standards* and are maintained to ensure easy and accurate identification of equipment.

(c) A *User* must ensure that technical drawings and documentation provided to the *Network Service Provider* comply with the specified *nomenclature standards*.

(d) The *Network Service Provider* may, by notice in writing, require a *User* to *change* the existing numbering or nomenclature of *transmission* and *distribution* equipment and apparatus of the *User* for purposes of uniformity.

ATTACHMENT 1 GLOSSARY

In these *Rules*, unless a contrary intention appears:

(a) a word or phrase set out in column 1 of the table below has the meaning set out opposite that word or phrase in column 2 of that table; and

(b) a word or phrase defined in the *Act* or the *Access Code* has the meaning given in that *Act* or that Code (as the case requires), unless redefined in the table below.

abnormal equipment conditions	Are, for the purpose of clause 2.9, those conditions that prevail at a particular location in the *power system* when the following circumstances exist: (a) the number of *generating units connected* to the *power system* is the least number normally *connected* at times of minimum *generation*; (b) there is one worst case *generating unit outage*; and (c) there are either: (1) no more than two *primary equipment outages*; or (2) no more than one *primary equipment outage* and no more than one *secondary equipment outage*. Where the *primary equipment outage(s)* are those which, in combination with the other circumstances of the kind listed in paragraphs (a) to (c) of this definition then existing, lead to the lowest fault current at the particular location, or to the maximum reduction in *sensitivity* of the remaining secondary system for the fault type under consideration, or to both.
Access	The meaning given in the *Access Code*. [Note: The definition in Unofficial Consolidated version of the Access Code, 30 July 2021, was: "**access**", in relation to *services,* has the meaning corresponding with the meaning that it has when used in that context in the *Competition and Consumer Act 2010* of the Commonwealth.]
access application	The meaning given in the *Access Code*. [Note: The definition in Unofficial Consolidated version of the Access Code, 30 July 2021, was: "**access application**" means— (a) an application lodged with a *service provider* under an *access arrangement* to establish or modify an *access contract* or to modify any other *contract for services*; and (b) a *prior application* and a *transitioned application*, and includes any additional information provided by the *applicant* in relation to the *application*.]
access arrangement	The meaning given in the *Access Code*. [Note: The definition in Unofficial Consolidated version of the Access Code, 30 July 2021, was: "**access arrangement**" means an arrangement for *access* to a *covered network* that has been approved by the *Authority* under this Code.]
Access Code	The Electricity Networks Access Code 2004 (WA)

access contract	The meaning given in the *Access Code*. [Note: The definition in Unofficial Consolidated version of the Access Code, 30 July 2021, was: **"access contract"** has the same meaning as 'access agreement' does in Part 8 of the Act, and under section 13.4(d) includes a deemed *access contract*.]
Act	The Electricity Industry Act 2004 (WA).
active energy	A measure of electrical energy flow, being the time integral of the product of *voltage* and the in-phase component of current flow across a *connection point*, expressed in watt hours (Wh) and multiples thereof.
active power	The rate at which *active energy* is transferred. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
active power capability	The maximum rate at which *active energy* may be transferred from a *generating unit* to a *connection point* as specified in the relevant *connection agreement*.
adequately damped	A system oscillation that complies with the requirements of clause 2.2.9(b) of these *Rules* is adequately damped. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
AEMO or Australian Energy Market Operator	The same meaning as "AEMO" or "Australian Energy Market Operator" in the *Access Code.* [Note: The definition in Unofficial Consolidated version of the Access Code, 30 July 2021, was: "**AEMO**" or "**Australian Energy Market Operator**" means the Australian Energy Market Operator Limited (ACN 072 010 327).]
agreed capability	In relation to a *connection point*, the capability to receive or send out *active power* and *reactive power* for that *connection point* determined in accordance with the relevant *connection agreement*.
apparent power	The positive square root of the sum of the squares of the *active power* and the *reactive power*. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
applicant	The meaning given in the *Access Code.* [Note: The definition in Unofficial Consolidated version of the Access Code, 30 July 2021, was: "**applicant**" means— (a) a person (who may be a *user*) who has lodged an *access application* under the *access arrangement* for a *covered network* to establish or modify a *contract for services*, and includes a *prospective applicant*; and (b) a *prior applicant*.]
approval to operate	The notification issued by the *Network Service Provider* granting final approval to a *User* to operate.
asynchronous generating system	A *generating system* comprised of *asynchronous generating units*. [Note: This definition aligns with the definition in Appendix 12 of the consolidated companion version of the *WEM Rules*, dated 22 July 2023.]

asynchronous generating unit	A *generating unit* that is not a *synchronous generating unit*.
augment, augmentation	The meaning given in the *Access Code*. [Note: The definition in Unofficial Consolidated version of the Access Code, 30 July 2021, was: "**augmentation**", in relation to a *covered network*, means an increase in the capability of the *covered network* to provide *covered services*.]
Australian Standard (AS)	The edition of a standard publication by Standards Australia (Standards Association of Australia) as at the date specified in the relevant clause or, where no date is specified, the most recent edition.
Authority	Means the Economic Regulation Authority established under the *Economic Regulation Authority Act 2003* (WA).
automatic reclose equipment	In relation to a *transmission line*, the equipment which automatically recloses the relevant line's circuit breaker(s) following their opening as a result of the detection of a fault in the *transmission line*.
back-up protection system	A *protection system* intended to supplement the *main protection system* in case the latter does not operate correctly, or to deal with faults in those parts of the *power system* that are not readily included in the operating zone of the *main protection system*. A *back-up protection system* may use the same circuit breakers as a *main protection system* and a *protection scheme* forming part of a *back-up protection system* may be incorporated in the same *protection apparatus* as the *protection schemes* comprising the *main protection system*.
black start-up equipment	The equipment required to provide a *generating unit* with the ability to start and synchronise without using electricity *supplied* from the *power system*.
busbar	A point of connection between two or more circuits in a *substation*.
business day	The meaning given in the *Access Code*. [Note: The definition in Unofficial Consolidated version of the Access Code, 30 July 2021, was: "**business day**" means a day that is not a Saturday, Sunday or public holiday throughout Western Australia.]
capacitor bank	A type of electrical equipment used to *generate reactive power* and therefore support *voltage* levels on *transmission lines* or *distribution* lines.
Cascading outage	The occurrence of an uncontrollable succession of *outage*s, each of which is initiated by conditions (e.g., instability or overloading) arising or made worse as a result of the event preceding it.
change	Includes amendment, alteration, addition or deletion.
Circuit breaker failure	A circuit breaker will be deemed to have failed if, having received a trip signal from a *protection scheme*, it fails to interrupt fault current within its design operating time.
Commitment	The commencement of the process of starting up and synchronising a *generating unit* to the *power system*.

Common requirements	In respect of each technical requirement specified in clause 3.3.7, those requirements that are common to both the *ideal generator performance standard* and *minimum generator performance standard*
connected	The state of physical linkage to or through the *transmission or distribution system*, by direct or indirect connection, so as to have an impact on *power system security*, *reliability* and *quality of supply*.
Connection agreement	An agreement or other arrangement between the *Network Service Provider* and a *User*, which may form part of or include an *access contract*, that specifies the technical requirements that apply in relation to the connection of a *User's* equipment to the *transmission or distribution system.* An Electricity Transfer Access Contract (ETAC) is an example of a *connection agreement.*
Connection asset	For a *connection point*, means all of the network assets that are used only in order to transfer electricity to or from the *connection point*.
Connection point	A point on the network where the *Network Service Provider*'s *primary equipment* (excluding metering assets) is *connected* to *primary equipment* owned by a *User*.
constraint	The meaning given in the *WEM Rules*. [Note: The definition in Chapter 11 of the consolidated companion version of the *WEM Rules*, dated 22 July 2023, was: **Constraint**: Means: (a) a Network Constraint; and (b) a limitation or requirement affecting the capability of a Load or Energy Producing System such that it would represent a risk to Power System Security or Power System Reliability if the limitation or requirement was removed.]
contingency event	An event affecting the *power system* that the *Network Service Provider* expects would be likely to involve the failure or removal from operational service of a *generating unit,* a *load*, *transmission element* or *distribution element*.

continuous uninterrupted operation	In respect of a *generating system* or operating *generating unit connected* to the *transmission or distribution system* and operating immediately prior to a *power system* disturbance: (a) not disconnecting from the *power system* except in accordance with its *generator performance standards*; (b) during the disturbance contributing active and reactive current as required by its *generator performance standards*; (c) after clearance of any electrical fault that caused the disturbance, only substantially varying its *active power* and *reactive power* as required or permitted by its *generator performance standards*; and (d) not exacerbating or prolonging the disturbance or causing a subsequent disturbance for other connected plant, except as required or permitted by its *generator performance standards*, with all essential auxiliary and reactive plant remaining in service. [Note: This definition aligns with the definition given in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
control centre	A *facility* used by *AEMO* or the *Network Service Provider* for directing the minute to minute operation of the *power system*.
control system	The means of monitoring and controlling the operation of the *power system* or equipment including *generating units connected* to a *transmission or distribution system*. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023]
controllable	Means that *voltages* at all major *busbar*s in the *transmission and distribution system* must be able to be maintained continuously at the target level notwithstanding variations in *load* or that some reactive sources may have reached their output limits in the post-fault steady state.
Co-ordinator of Energy	The same meaning as "Coordinator" in the Access Code. [Note: The definition in Unofficial Consolidated version of the Access Code, 30 July 2021, was: "**Coordinator**" means the Coordinator of Energy referred to in section 4 of the *Energy Coordination Act 1994*.]
credible contingency	A contingency that is considered for the purposes of assessing *power system* security and that must not result in the remaining *power system* being in breach of the stated planning or operational criteria outlined in these *Rules*. Credible contingencies are individually specified throughout Chapter 2 and Chapter 5 of these Rules. A *credible contingency* is initiated by a *credible fault event* or the sudden disconnection of a system component e.g., a *transmission line* or a *generating unit.* [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]

credible fault event	Means any of the following fault events that initiate a *credible contingency*: (a) for *voltages* at 66kV or below: three phase to earth fault cleared by disconnection of the faulted component, with the fastest *main protection scheme* out of service; (b) for *voltages* above 66kV, either: (1) a two-phase to earth fault cleared by disconnection of the faulted component, with the fastest *main protection scheme* out of service; or (2) a three-phase to earth fault cleared by disconnection of the faulted component, with the fastest *main protection scheme* out of service. This criterion is to be applied only to *transmission elements* where the *Network Service Provider* can demonstrate that the design type, environmental conditions, historic performance or operational parameters results in a material increase in the likelihood of a three-phase to earth fault occurring; (c) a single-phase to earth fault cleared by the *disconnection* of the faulted component, with the fastest *main protection scheme* out of service; (d) a single-phase to earth fault cleared after unsuccessful high-speed single-phase auto-reclosure onto a persistent fault; or (e) a single-phase to earth *small zone fault* or a single-phase to earth fault followed by a *circuit breaker failure*, in either case cleared by the operation of the fastest available *protection scheme.*
critical fault clearance time	The maximum *total fault clearance time* that the *power system* can withstand without one or both of the following conditions arising: (a) instability; (b) unacceptable disturbance of *power system voltage* or *frequency*. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023]
current rating	The maximum current that may be permitted to flow (under defined conditions) through a *transmission line* or *distribution* line or other item of equipment that forms part of a *power system*.
current transformer (CT)	A *transformer* for use with meters or *protection* devices or both in which the current in the secondary winding is, within prescribed error limits, proportional to and in phase with the current in the primary winding.
customer	The meaning given in the *Access Code.* [Note: The definition in Unofficial Consolidated version of the Access Code, 30 July 2021, was: "**customer**" means a: (a) *user*, or (b) *end-user customer* in the *end-use customer's* capacity as indirect customer for *covered services.]*

damping ratio	A standard mathematical parameter that characterises the shape of a damped sine wave.
decommission	The act of causing a *generating unit* to cease generating indefinitely and *disconnect*ing it from a *transmission or distribution system*.
demand group	A site or group of sites that collectively take power from the remainder of the *transmission system.*
direction	A requirement issued by the *Network Service Provider* or *AEMO* to any *User* requiring the *User* to do any act or thing which the *Network Service Provider* or *AEMO* considers necessary to maintain or re-establish *power system security* or to maintain or re-establish the *power system* in a reliable operating state in accordance with these *Rules*.
disconnect	The operation of switching equipment or other action so as to prevent the flow of electricity at a *connection point*.
dispatch	The act of the *Network Service Provider* or *AEMO* in committing to service all or part of the *generation* available from a *generating unit*, permitting a particular level of *active power* consumption by a *load* or requiring a *load* or *generating system* to operate with a particular control mode enabled.
dispatch systems requirements	The meaning given in the *WEM Rules*. [Note: The definition in Appendix 12 of the consolidated companion version of the *WEM Rules*, dated 22 July 2023, was: **Dispatch Systems Requirements:** Means the requirements described in section 2.35.]
distribution	The functions performed by a *distribution system*, including conveying, transferring or permitting the passage of electricity.
distribution element	A single identifiable major component of a *distribution system.*
distribution feeder	In the *power system*, a *high voltage* radial circuit forming part of the *distribution system* that is supplied from a *zone substation*.
Distribution Network Operator	The *Network Service Provider* personnel, systems and infrastructure that perform operational roles and responsibilities that provide for the safe, secure and reliable operation of the *distribution system.*
distribution system	Any apparatus, equipment, plant or buildings used, or to be used, for, or in connection with, the transportation of electricity at nominal *voltage*s of less than 66 kV and which form part of the *South West Interconnected Network*.
dynamic performance	The response and behaviour of networks and *facilities* that are *connected* to the networks when the normal operation of the *power system* is disturbed.

electricity storage	A device consisting of 'storage works' as defined in the *Act* but does not include non-dispatchable *active power* energy storage equipment such as a synchronous compensator or flywheel. When discharging *active power*, *electricity storage facilities* are considered as *generation* and must meet the relevant clauses of the *Rules*. When consuming *active power*, *electricity storage facilities* are considered as *load* and must meet the relevant clauses of the *Rules*. [Note: The definition in the *Act* as of the version that came into affect on 7 April 2020 was: ***storage works*** means any wires, apparatus, equipment, plant or buildings used, or to be used, for, or in connection with, or to control, a storage activity] [Note: This definition aligns with the definition in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023 except that it references the *Act* definition and provides further clarity required in the context of these *Rules.*]
embedded system	Means a network *connected* at a *connection point* on the *SWIS* that is owned, controlled or operated by a person who is not the *Network Service Provider* or *AEMO.*
emergency conditions	For the *power system*, the operating conditions applying after a significant *transmission element* has been removed from service other than in a planned manner.
emergency return to service	The pre-agreed time to recall a *planned outage* following an unplanned event.
EMT	Electromagnetic transient.
energisation	The act or process of operating switching equipment or starting up a *generating unit*, which results in there being a non-zero *voltage* beyond a *connection point* or part of the *transmission system* or the *distribution system*.
energy	*Active energy* or reactive *energy*, or both.
essential services	Essential services include, but are not necessarily limited to, services such as hospitals and railways where the maintenance of a *supply* of electricity is necessary for the maintenance of public health, order and safety.
essential system services	The meaning given in the *WEM Rules*. [Note: The definition in Chapter 11 of the consolidated companion version of the *WEM Rules*, dated 22 July 2023, was: **Essential System Services**: A service, including each service described in section 3.9, that is required to maintain Power System Security and Power System Reliability, facilitate orderly trading in electricity and ensure that electricity supplies are of an acceptable quality.]
excitation control system	In relation to a *generating unit*, the automatic control system that provides the field excitation for the *generating unit* (including excitation limiting devices and any *power system* stabiliser). [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
extension	An *augmentation* that requires the connection of a power line or *facility* to the *transmission or distribution system*.

Equipment	A device used in generating, transmitting or utilising electrical energy, making available electric power, or communicating information that supports the management of power flow. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023 but is no longer used as a defined term in these *Rules.* The definition is retained here to enable use of the term in *WEM Rules* application only.]
facility	An installation comprising equipment and associated apparatus, buildings and necessary associated supporting resources used for or in connection with *generating*, conveying, transferring, or consuming electricity, and includes: (a) a *power station* or *generating system*; (b) a *substation*; (c) equipment by which electricity is consumed; (d) *electricity storage;* and (e) a *control centre*.
Fault clearance time	The time interval between the occurrence of a fault and the fault clearance.
Fault outage	An *outage* of one or more items of equipment or *generation* initiated by automatic action unplanned at that time, which may or may not involve the passage of fault current.
Financial year	A period of 12 *months* commencing on 1 July.
Frequency	For alternating current electricity, the number of cycles occurring in each second, measured in Hz.
Frequency dead band	The range through which *power system frequency* can vary without the *frequency* control system initiating an *active power* response.
Frequency operating standards	The standards that specify the *frequency* levels for the operation of the *power system* set out in clause 2.2.1(a).
frequency stability	The ability of a *power system* to attain a steady *frequency* following a severe system disturbance that has resulted in a severe imbalance between *generation* and *load*. Instability that may result occurs in the form of sustained *frequency* swings leading to tripping of *generating units* or *loads* or both.
Frequent operational switching	Operation of plant and equipment which is undertaken regularly on the *transmission or distribution system*. For the avoidance of doubt *frequent operational switching* comprises manual and automatic initiation of switching actions including, but not limited to, *transformer* tap changing, capacitor/*reactor* switching, switching of circuits for *voltage* control or safe access, etc.
generated	In relation to a *generating unit*, the amount of electricity produced by the *generating unit* as measured at its terminals.
Generating equipment	In relation to a *connection point*, includes all equipment involved in generating electrical *energy* transferred at that *connection point*.

Generating system	A system comprising one or more *generating units*. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
generating unit	The equipment used to generate electricity and all the related equipment essential to its functioning as a single entity. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
generation	The production of electric power by converting another form of *energy* into electricity in a *generating unit*. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
generation circuit	The sole electrical connection between one or more *generating units* and the *transmission system*. It is a radial circuit that, if removed, would *disconnect* the *generation* from the *transmission system*.
Generator	Any person (including a *User* or the *Network Service Provider*) who owns, controls or operates a *generating system* that supplies or is capable of supplying electricity to, or who otherwise supplies electricity, to the *transmission system* or *distribution system*.
Generator performance chart	The meaning given in the *WEM Rules*. [The definition in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023, was: **Generator Performance Chart:** Means a chart defining the capability of a Generating System or Generating Unit to produce Active Power while producing or consuming Reactive Power. The capability is provided for specified ambient conditions and voltage levels at the Measurement Location based on a template provided by the Network Operator. The chart shows the Reactive Power capability continuously achievable while in operation, subject to energy source availability, for a given level of Active Power output for a range of ambient temperatures, while not exceeding limits necessary to prevent damage to Equipment and ensure compliance with other Technical Requirements.]
generator performance standard	A standard of performance which a *Generator* must achieve and establish through the process described in clause 3.3.4 of these *Rules*. The *generator performance standards* for a *large generating system* must address each of the technical requirements in clause 3.3.7 of these *Rules*. [Note: This definition aligns with the equivalent definition in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
good electricity industry practice	The meaning given in the *Access Code*. [Note: The definition in Unofficial Consolidated version of the Access Code, 30 July 2021, was: **“good electricity industry practice**” means the exercise of that degree of skill, diligence, prudence and foresight that a skilled and experienced person would reasonably and ordinarily exercise under comparable conditions and circumstances consistent with applicable *written laws* and *statutory instruments* and applicable recognised codes, standards and guidelines.]
gradual bumpless transfer	The make-before-break transfer of a *load* between the *distribution system* and an islanded *generating unit* (or vice versa) where the time for which the *generating unit* is operated in parallel with the *distribution system* is limited to less than 60 seconds.

group demand	The forecast maximum demand for a single *demand group* taking demand from the *transmission system* in accordance with the requirements of these *Rules*.
halving time	The elapsed time required for the magnitude of a damped sine wave to reach half its initial value.
high voltage (HV)	Any nominal *voltage* above 1 kV. Note: *MV* is a subset of *HV*.
ideal generator performance standard	A *Generator* that meets the *ideal performance standard* for a particular technical requirement will not be refused connection to the network because of that technical requirement. The *ideal generator performance standard* for each technical requirement is defined in clause 3.3.7 of these *Rules*. [Note: This definition aligns with the equivalent definition in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
induction generating unit	An alternating current *generating unit* whose rotor currents are produced by induction from its stator windings and, when driven above synchronous speed by an external source of mechanical power, converts mechanical power to electric power by means of a conventional induction machine.
infeed loss risk limit	The meaning given in clause 2.5.3.1(b) of these *Rules*.
infrequent operational switching	Operation of plant and equipment associated with rare or infrequent events. *Infrequent operational switching* comprises manual and automatic initiation of switching actions including, but not limited to, isolation of circuits for maintenance and subsequent re-energisation, operation of intertrip schemes consequent upon a *credible contingency*, etc.
intact system	The *transmission system* with no *planned outages* and no *unplanned outages*.
interconnection	A *transmission line* or group of *transmission lines* that connects the *transmission systems* in adjacent *regions*.
interim approval to operate	The notification issued by the *Network Service Provider*, which may or may not be subject to and contain conditions, granting interim approval to a *User* to operate.
intermittent generating system	Any *generating system* whose output is not reasonably controllable by the *Network Service Provider* or *AEMO,* and whose output is dependent on a fuel resource that cannot be directly stored or stockpiled and whose availability is difficult to predict. [Note: This definition aligns with the definition in Chapter 11 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
inverter	A device that uses semiconductor devices to transfer power between a DC source or *load* and an AC source or *load.* *Inverters* include AC to AC convertors transferring power between non-grid *energy* sources and an AC source or *load* that use semiconductor devices.
inverter energy system	A system comprising one or more *inverters* together with one or more *energy* sources (which may include *electricity storage*), and controls, which comply with the requirements of AS/NZS 4777 series.

large disturbance	A disturbance sufficiently large or severe as to prevent the linearization of system equations for the purposes of analysis. The resulting system response involves large excursions of system variables from their pre-disturbance values, and is influenced by non-linear power-angle relationship and other non-linearity effects in *power systems*. *Large disturbance* is typically caused by a short circuit on a nearby *power system* component (for example, *transmission line*, *transformer*, etc.).
large generating system	A *generating system* with a total rated capacity exceeding 5 MVA.
large load	A *load connection point* that is rated to consume more than 5 MVA of power from the *transmission or distribution system*.
load	Either: (a) a *connection point* at which electric power is made available to a person; or (b) the amount of electric *power transfer* at a defined instant at a specified point on the *transmission or distribution system* as the case requires.
load shedding	Reducing or disconnecting *load* from the *power system*.
local system outage	For a *demand group*, a *planned outage* or *unplanned outage* local to the *demand group* that has a direct effect on the *supply* capacity to that *demand group*. For *generation* connections, a *planned outage* local to the *generation* that has a direct effect on the *generation* connection.
loss of demand	The reduction in the demand supplied by the *transmission system* to one or more *demand groups*.
loss of power infeed	The meaning given in clause 2.5.3.1(a) of these *Rules*.
low voltage (LV)	Any nominal *voltage* of 1 kV and below.
Main Interconnected Transmission system or MITS	In the context of the *SWIS*, the meaning given in clause 2.5.2(b) of these *Rules*.
main protection scheme	A *protection scheme* that has the primary purpose of disconnecting specific equipment from the *transmission and distribution system* in the event of a fault occurring within that equipment.
main protection system	A *protection system* that has the primary purpose of disconnecting specific equipment from the *transmission and distribution system* in the event of a fault occurring within that equipment.
maintenance conditions	The operating conditions that exist when a significant element of the *transmission system* or the *distribution system* has been taken out of service in a planned manner so that maintenance can be carried out safely.

maintenance period demand	The expected maximum demand for a *demand group* during the maintenance period. Where better data is unavailable, this should be taken as 80% of the forecast *group demand*.
major augmentation	The meaning given in the *Access Code*. [Note: The definition in Unofficial Consolidated version of the Access Code, 30 July 2021, was: **"major augmentation**" means an *augmentation* for which the *new facilities investment* for the *shared assets*: (a) exceeds $10 million (*CPI adjusted*), where the *network assets* comprising the *augmentation* are, or are to be, part of a *distribution system*; and (b) exceeds $30 million (*CPI adjusted*), where the *network assets* comprising the *augmentation* are, or are to be, part of: (i) a *transmission system*; or (ii) both a *distribution system* and a *transmission system*.]
market generation	The *generation* produced from a *generating unit* or *generating system* operated by a *market generator.*
market generator	A *User* who is registered as a Market Generator in accordance with the *WEM Rules.*
maximum continuous current	The maximum current capable of being injected continuously in accordance with the relevant *Australian Standard* or ISO Standard for *synchronous generating units* and *asynchronous generating units* at the *measurement location* by the *generating system* or *generating units*, as applicable, in order to support maintaining voltage on the *SWIS* during a disturbance, without causing damage to, or maloperation of, equipment in the *generating system*. The details regarding which relevant *Australian Standard* or ISO Standard applies is documented in the guidelines published by the *Network Service Provider* under clause 3A.4.4 of the *WEM Rules*. [Note: This aligns with the definition given in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
maximum fault current	The current that will flow to a fault on an item of equipment when *maximum system conditions* prevail.
maximum reasonably foreseeable load	Determined by estimating the *peak load* of the area after it has been fully developed, taking into account restrictions on land use, assuming future electricity consumption patterns and impacts from climate change and emerging technologies.
maximum system conditions	For any particular location in the *power system*, those conditions that prevail when the maximum number of *generating units* that are normally *connected* at times of maximum *generation* are so *connected*.
maximum temperature	The maximum ambient temperature specified by the *Network Service Provider* in consultation with the *AEMO*, based on an assessment of the physical location of the *generating system*. [Note: This definition aligns with the definition given in the companion *WEM Rules* dated 22 July 2023.]

measurement location	The meaning given in the *WEM Rules*. [The definition in Appendix 12 of the consolidated companion version of the *WEM Rules,* dated 22 July 2023, was: **Measurement location:** The Connection Point, or another measurement location agreed by AEMO and the Network Operator, as specified for the relevant Technical Requirement.]
medium voltage (MV)	Any nominal *voltage* above 1 kV and below 35 kV. [Note: MV is a subset of HV.]
minimum fault current	The current that will flow to a fault on an item of equipment when *minimum system conditions* prevail.
minimum generator performance standard	A *Generator* that does not meet the *minimum generator performance standard* for a technical requirement will not be allowed to connect because of that technical requirement. The *minimum generator performance standard* for each technical requirement is defined in clause 3.3.7 of these *Rules*. [Note: This definition does not align with the definition given in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023]
minimum system conditions	For any particular location in the *power system*, those conditions that prevail when: (a) the least number of *generating units* normally *connected* at times of minimum *generation* are so *connected*; and (b) there is one *primary equipment outage*. The *primary equipment outage* is taken to be that which, in combination with the minimum *generation*, leads to the lowest fault current at the particular location for the fault type under consideration.
monitoring equipment	The testing instruments and devices used to record the performance of equipment for comparison with expected performance.
month	The meaning given to it in section 62 of the *Interpretation Act 1984* (WA).
nameplate rating	The maximum continuous output or consumption specified either in units of *active power* (watts) or *apparent power* (volt-amperes) of an item of equipment as specified by the manufacturer. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
negotiated generator performance standard	A performance standard for a particular technical requirement that has been determined via the process in clause 3.3.4 of these *Rules*.
negotiation criteria	The criteria that must be met in respect of each technical requirement in clause 3.3.7 of these *Rules* if a *Generator* submits a *proposed negotiated generator performance standard*.
Network Service Provider	The meaning given to it in clause 1.3(a) of these *Rules*.
new capacity	Any increase in electricity *generation*, *transmission* or *distribution* capacity which would arise from enhancement to or expansion of the electricity *generation*, *transmission system* or *distribution system*.

nomenclature standards	The standards approved by the *Network Service Provider* relating to numbering, terminology and abbreviations used for information transfer between *Users* as provided for in clause 5.9 of these *Rules*. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
non-co-optimised essential system service (NCESS)	The meaning given in the *WEM Rules*. [Note: The definition in Chapter 11 of the consolidated companion version of the *WEM Rules,* dated 22 July 2023, was: **Non-Co-optimised Essential System Service:** An Essential System Service procured under section 3.11B.]
non-intermittent generating system	A *generation system* that is not an *intermittent generating system*, including, without limitation, thermal generators fuelled by coal, natural gas, or distillate [Note: This definition aligns with the definition in Chapter 11 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
non-market generation	The *generation* produced from *generating unit* or *generating system* operated by a *non-market generator.*
non-market generator	A *generator* that is not a *market generator.*
non-scheduled generating system	A *generating system* that is not dispatched by *AEMO*.
operational communication	A communication concerning the arrangements for, or actual operation of, the *power system* in accordance with the *Rules*.
operational timescales	The timescales under which decisions are made regarding the efficient operation of the existing *power system* to ensure compliance with Chapter 5 of these *Rules* and the *WEM Rules*. This includes decisions regarding outage planning, the co-ordination of network and generation outages, operational switching, the adjustment of control settings, the operation of plant and equipment, and utilisation of contracted services. Operational timescales typically cover the period from real time to 1 year ahead and may, in some circumstances, cover longer forward looking periods.
operator	The person or organisation responsible for the provision of service in real time.
outage	Any planned or unplanned full or partial unavailability of equipment.
peak load	Maximum *load*
Perth CBD	The geographical area in the City of Perth bound by Hill Street (East), Havelock Street (West), Wellington Street (North) and Riverside Drive and Kings Park Road (South).
planned outage	An *outage* of one or more items of equipment and/or *generation* initiated by manually instructed action that has been subject to an *outage* process managed by the *Network Service Provider* or *AEMO.* [Note: This term is analogous to a scheduled outage under the *WEM Rules*.]

planning timescales	The timescales under which decisions are made regarding investments that provide the *power system* capability necessary to deliver an efficient, secure, adequate and reliable system and enable the *power system* to meet the criteria defined in Chapter 2 of these *Rules*. Planning timescales typically cover the period 1 year ahead to 10 years ahead.
point of common coupling	The point on the network where *connection assets* associated with a *connection point* are *connected* to primary network assets that are shared with other *Users.*
potential relevant generator modification	The meaning given in clause 3.3.5 of these *Rules*.
power factor	The ratio of the *active power* to the *apparent power* at a point. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
power station	The one or more *generating units* at a particular location and the apparatus, equipment, buildings and necessary associated supporting resources for those *generating units*, including *black start-up* equipment, step-up *transformers*, *substations* and the *power station control centre*. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
power system	The electric *power system* constituted by the *South West Interconnected Network* and its *connected generation* and *loads*, operated as an integrated system.
power system operating procedures	The procedures to be followed by *Users* in carrying out operations and maintenance activities on or in relation to *primary equipment* and *secondary equipment connected* to or forming part of the *power system* or *connection points*, as described in clause 5.7.1 of these *Rules*.
power system reliability	The meaning given in the *WEM Rules*. [Note: The definition in Chapter 11 of the consolidated companion version of the *WEM Rules*, dated 22 July 2023, was: **Power System Reliability:** Means the safe scheduling, operation and control of the SWIS in accordance with the Power System Reliability Principles.]
power system security	The meaning given in the *WEM Rules*. [Note: The definition in Chapter 11 of the consolidated companion version of the *WEM Rules*, dated 22 July 2023, was: **Power System Security:** Means the safe scheduling, operation and control of the SWIS in accordance with the Power System Security Principles.]
power system stability	The ability of the *power system*, for a given initial operating condition, to regain a state of operating equilibrium after being subjected to a physical disturbance, with most system variables bounded so that practically the entire system remains intact.
power transfer	The instantaneous rate at which *active energy* is transferred between *connection points*.

power transfer capability	The maximum permitted *power transfer* through a *transmission or distribution system* or part thereof.
pre-disturbance steady state voltage limits	The *voltage* limits for use in *planning timescales* for circumstances before a fault, as detailed in clause 2.2.2 of these *Rules*.
pre-fault rating	The specified pre-fault continuous capability of *transmission* equipment with consideration for the specific conditions (e.g., ambient/seasonal temperature), time-dependent loading cycles of equipment and any additional relevant procedures. In operational timeframes, dynamic ratings may also be used where available.
prevailing system conditions	The conditions on the *transmission system* prevailing at any given time. These conditions normally include *planned outages*, *unplanned outages* and may include *fault outages*.
primary equipment	Refers to apparatus that conducts *power system load* or conveys *power system voltage*. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
priority project	The meaning given in the *Access Code*. [Note: The definition in Unofficial Consolidated version of the Access Code, 30 July 2021, was: "**priority project**" means a project specified as a priority project in a *whole of system plan*.]
proposed generator performance standard	A *generator performance standard* proposed to apply to a *larger generating system* that has not been approved and registered in accordance with the process in clause 3.3.4.
proposed negotiated generator performance standard	A *proposed generator performance standard* that is not an *ideal generator performance standard* but is no less than the *minimum generator performance standard*.
protection	The detection, limiting and removal of the effects of *primary equipment* faults from the *power system*; or the apparatus, device or system required to achieve this function.
protection apparatus	Includes all relays, meters, power circuit breakers, synchronisers and other control devices necessary for the proper and safe operation of the *power system*.
protection scheme	An arrangement of *secondary equipment* designed to protect *primary equipment* from damage by detecting a fault condition and sending a signal to *disconnect* the *primary equipment* from the *transmission or distribution system*. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 1 February 2023.]

protection system	A system designed to *disconnect* faulted *primary equipment* from the *transmission or distribution system* that includes one or more *protection schemes* and which also includes the *primary equipment* used to effect the disconnection. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 1 February 2023.]
quality of supply	With respect to electricity, technical attributes to a standard set out in clause 2.2 of these *Rules*, unless otherwise stated in these *Rules* or the relevant *connection agreement*.
rapid bumpless transfer	The make-before-break transfer of a *load* between *the distribution system* and an islanded *generating unit* (or vice versa) where the time for which the *generating unit* is operated in parallel with the *distribution system* is limited to less than 1 second.
rate of change of frequency (RoCoF)	The rate of change of *frequency*, expressed in Hertz per second.
rated maximum active power	The meaning given in the *WEM Rules*. [Note: The definition in Appendix 12 of the consolidated companion of the *WEM Rules*, dated 22 July 2023, was: **Rated Maximum Active Power**: The maximum Active Power level that a Generating Unit or Generating System, as applicable, can continuously deliver at the Measurement Location, subject to energy source availability, in accordance with the requirements of Part A12.2 when the ambient temperature is at the Maximum Temperature, as specified in the Temperature Dependency Data.]
rated maximum apparent power	The meaning given in the *WEM Rules*. [Note: The definition in Appendix 12 of the consolidated companion version of the *WEM Rules*, dated 22 July 2023, was: **Rated Maximum Apparent Power**: The maximum Apparent Power level that a Generating Unit or Generating System, as applicable, can continuously deliver at the Measurement Location, subject to energy source availability, when operating at the extent of the Generator Performance Chart provided under Part A12.3 and the ambient temperature is at the Maximum Temperature.]
rated minimum active power	The meaning given in the *WEM Rules*. [Note: The definition in Appendix 12 of the consolidated companion version of the *WEM Rules*, dated 22 July 2023, was: **Rated Minimum Active Power:** Means (a) in relation to a Generating Unit, the minimum amount of Active Power that the Generating Unit can continuously deliver, subject to energy source availability, while maintaining stable operation at the Measurement Location; and (b) in relation to a Generating System, the combined minimum amount of Active Power that its in-service Generating Units can continuously deliver, subject to energy source availability, at the Measurement Location while maintaining stable operation.]
reactive energy	A measure, in var hours (varh), of the alternating exchange of stored energy in inductors and capacitors, which is the time-integral of the product of *voltage* and the out-of-phase component of current flow across a *connection point*.

reactive equipment	Equipment which is normally provided specifically to be capable of providing or absorbing *reactive power*. Examples of equipment include *synchronous generating unit voltage controls* usually associated with tap-changing *transformers*; or *generating unit* AVR set point control (rotor current adjustment), *synchronous condensers* (compensators), *static var compensators (SVC)*, *static synchronous compensators (STATCOM)*, *shunt capacitors*, *shunt reactors*; and series capacitors, etc.
reactive power	The rate at which *reactive energy* is transferred, measured in var. *Reactive power* is a necessary component of alternating current electricity which is separate from *active power* and is predominantly consumed in the creation of magnetic fields in motors and *transformers* and produced by equipment such as: (a) alternating current *generating units*; (b) capacitors, including the capacitive effect of parallel *transmission* wires; (c) *synchronous condensers*. *Reactive power* is obtained from a combination of static and dynamic sources. Static sources include, for example, *reactors* and *capacitor banks*, and the charging current of *transmission lines*. Dynamic sources include, for example, synchronous machines, operating as *generating units* or *synchronous compensators*, *static synchronous compensators*, and *static var compensators*. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
reactive power capability	The maximum rate at which *reactive energy* may be transferred from a *generating unit* to a *connection point* as specified in the relevant *connection agreement*. [Note: This definition is different from the definition in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023]
reactive power reserve	Unutilised sources of *reactive power* arranged to be available to cater for the possibility of the unavailability of another source of *reactive power* or increased requirements for *reactive power*.
reactor	A device, similar to a *transformer*, arranged to be *connected* into the *transmission or distribution system* during periods of low demand or low *reactive power* demand to counteract the natural capacitive effects of long *transmission lines* in generating excess *reactive power* and so correct any *transmission voltage* effects during these periods.
rectification plan	A plan to address non-compliance with technical performance requirements proposed by a *Generator* and approved by the *Network Service Provider* in accordance with clause 4.1.3.

region	An area determined by the *Network Service Provider* to be a *region*, being an area served by a particular part of the *transmission system* containing one or more: (a) concentrated areas of *load* or *loads* with a significant combined consumption capability; or (b) concentrated areas containing one or more *generating units* with significant combined generating capability, or both.
registered generator performance standard	Each *generator performance standard* in respect of a technical requirement applying to a *large generating system* that has been approved and registered in accordance with the process in clause 3.3.4 of these *Rules*.
relevant generator modification	A *potential relevant generator modification* that the *Network Service Provider* declares to be a *relevant generator modification*.
remote communication equipment	Equipment installed to enable the *Network Service Provider* to communicate with a *User's* equipment. [Note: This definition is used in Appendix 12 of the consolidated companion version of *WEM Rules* dated 22 July 2023 but there is no definition given in the *WEM Rules*.]
remote control equipment (RCE)	Equipment installed to enable the *Network Service Provider* to control a *generating unit* circuit breaker or other circuit breaker remotely. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
remote monitoring equipment (RME)	Equipment installed to enable the monitoring of other equipment from a remote *control centre*, and includes a *remote terminal unit* (*RTU*). [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
remote switching time	The time it would typically take to carry out remote switching from the *Network Service Provider's control centre*.
remote terminal unit (RTU)	A remote terminal unit installed within a *substation* to enable monitoring and control of equipment from a remote *control centre*.
representative	In relation to a person, any employee, agent or consultant of: (a) that person; (b) a related body corporate of that person; or (c) a third party contractor to that person.
reserve	The *active power* and *reactive power* available to the *power system* at a nominated time but not currently utilised.
restart plan	Operational plan for restarting the *power system* following a system shutdown developed by *AEMO* in accordance with the *WEM Rules.*
revision	The *revision* to the *Rules* following an amendment under sections 12.50 - 12.54A, or a review under section 12.56, of the *Access Code* and approval by the *Authority.*

rise time	The meaning given in the *WEM Rules*. [Note: The definition in Appendix 12 of the consolidated companion version of the *WEM Rules,* dated 22 July 2023, was: **Rise Time:** In relation to a control system, means the time taken for an output quantity to rise from its initial value to 90% of the final value induced by a step change of an input quantity, including in response to a disturbance as required under section A12.9.]
Rules	These *Rules*, also called the "Technical Rules", prepared by the *Network Service Provider* under Chapter 12 of the *Access Code*.
Rules commencement date	The date given in clause 1.4 of these *Rules*.
SCADA system	Supervisory control and data acquisition equipment which enables *AEMO* or the *Network Service Provider* to monitor continuously and remotely, and to a limited extent control, the import or export of electricity from or to the *power system*.
Scheduled generating system	A *generating system* that is *dispatched* by *AEMO*.
Secondary equipment	Equipment within a *facility* or the electricity *transmission or distribution system* which does not carry the *energy* being transferred, but which is required for control, *protection* or operation of other equipment that does carry such *energy*.
Sensitivity	In relation to *protection schemes*, means the ability to detect faults.
Service provider	The meaning given in the *Access Code*. [Note: The definition in Unofficial Consolidated version of the Access Code, 30 July 2021, was: **"service provider"**, in relation to a *network*, means a person who owns or operates the *network*.]
settling time	In relation to a control system, means the time measured from initiation of a step change in an input quantity to the time when the magnitude of error between the output quantity and its final settling value remains less than 10% of: (a) if the sustained change in the quantity is less than half of the maximum change in that output quantity, half of the maximum change induced in that output quantity; or otherwise (b) the sustained change induced in that output quantity.
short circuit ratio	The synchronous three phase fault level in MVA at the *connection point* divided by the rated output of the *generating unit* or *generating system* (expressed in MW or MVA, at the *Network Service Provider's* discretion).
shunt capacitor	A type of equipment *connected* to a *transmission or distribution system* to generate *reactive power*.
shunt reactor	A type of equipment *connected* to a *transmission or distribution system* to absorb *reactive power*.

small disturbance	A disturbance sufficiently small to permit the linearization of system equations for the purposes of analysis. The resulting system response involves small excursions of system variables from their pre-disturbance values. *Small disturbances* may be caused by routine switching (for example, line or capacitor), *transformer* tap changes, *generating unit* AVR set point changes, changes in the *connected load*, etc.
small generating system	A *generating system* with a total rated capacity less than or equal to 5 MVA.
small use customer	A *User* who consumes less than 160 MWh of electricity per annum.
small zone fault	A fault which occurs on an area of equipment that is within the zone of detection of a *protection scheme*, but for which not all contributions to the fault will be cleared by the circuit breaker(s) tripped by that *protection scheme*. For example, a fault in the area of equipment between a *current transformer* and a circuit breaker, fed from the *current transformer* side, may be a *small zone fault*.
South West Interconnected Network (SWIN)	The network parts of the *SWIS*.
South West interconnected system (SWIS)	The meaning given in the *Act*. [Note: The definition in the Act as of the version that came into affect on 7 April 2020 was: ***South West interconnected system*** means the interconnected transmission and distribution systems, generating works and associated works — (a) located in the South West of the State and extending generally between Kalbarri, Albany and Kalgoorlie; and (b) into which electricity is supplied by — (i) one or more of the electricity *generation* plants at Kwinana, Muja, Collie and Pinjar; or (ii) any prescribed electricity *generation* plant]
spare capacity	Any portion of firm capacity or non-firm capacity not committed to existing *Users*.
standard connection service	The same meaning as "standard connection service (supply) Western Power" in the *WA Service and Installation Requirements*.
static excitation system	An *excitation control system* in which the power to the rotor of a *synchronous generating unit* is transmitted through high power solid-state electronic devices. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
static synchronous compensator (STATCOM)	A device provided on a *transmission or distribution system* specifically to provide the ability to generate and absorb *reactive power* and to respond automatically and rapidly to *voltage* fluctuations or *voltage* instability arising from a disturbance or disruption on the *transmission or distribution system.*

static var compensator (SVC)	A device provided on a *transmission or distribution system* specifically to provide the ability to generate and absorb *reactive power* and to respond automatically and rapidly to *voltage* fluctuations or *voltage* instability arising from a disturbance or disruption on the *transmission or distribution system*.
steady state voltage	The *voltage* measured in the absence of any *contingency event* or following a *contingency event* once sufficient time has passed for automatic *voltage* control devices to have operated (such as on *load transformer* tap adjustment or automatic switching of *reactive equipment*).
sub transmission system	In the context of the *SWIS*, the meaning given in clause 2.5.2(c) of these *Rules*.
substation	A *facility* at which lines are switched for operational purposes, and which may include one or more *transformers* so that some *connected* lines operate at different nominal *voltages* to others.
sub-synchronous oscillations	*Power system* oscillations at frequencies that are less than the power *frequency*. They arise from modes of oscillation associated with interactions between certain elements on the *transmission system* such as *generating unit* rotor circuits, shaft systems, series compensated lines, *excitation control systems* and *power system* stabilisers.
supply	The delivery of electricity as defined in the *Act*.
switchable feeder section	A section of a high *voltage distribution feeder* that can be switched into or out of service by means of manual or remote switching.
synchronisation	The act of synchronising a *generating unit* to the *power system*.
synchronism	A condition in which all machines of the synchronous type (*generating units* and motors) that are *connected* to a *transmission or distribution system* rotate at the same average speed, resulting in controlled sharing of the transfer of power. Loss of *synchronism* causes uncontrolled transfers of power between machine groups, causing severe and widespread disturbances of *supply* to *Users*, disconnection of *transmission lines*, possible damage to synchronous machines and system shutdown. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
synchronous condenser or synchronous compensator	An item of equipment, similar in construction to a *generating unit* of the *synchronous generating unit* category, which operates at the equivalent speed of the *frequency* of the *power system*, provided specifically to generate or absorb *reactive power* through the adjustment of rotor current.
synchronous generating unit	The alternating current *generating units* that operate at the equivalent speed of the *frequency* of the *power system* in its normal operating condition. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
synchronous generating system	A *generating system* comprised of *synchronous generating units*. [Note: This definition aligns with the definition given in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]

synchronous generating unit voltage control	The automatic *voltage* control system of a *generating unit* of the *synchronous generating unit* category which *change*s the output *voltage* of the *generating unit* through the adjustment of the *generating unit* rotor current and effectively *change*s the *reactive power* output from that *generating unit*.
system instability	This constitutes: (a) Inadequate transient stability – where the requirements of clause 2.2.8 of these *Rules* are not met (b) Inadequate *power system* damping – where the requirements of clause 2.2.9 of these *Rules* are not met. (c) Unacceptable *sub-synchronous oscillations* where the relevant modes of oscillation are negative or there is insufficient net damping such that the requirements in clause 2.2.9 of these *Rules* are not met.
system strength	The meaning given in the *WEM Rules*. [Note: The definition in Chapter 11 of the consolidated companion version of the *WEM Rules*, dated 22 July 2023, was: **System Strength**: Is a measure of how resilient the voltage waveform is to disturbances such as those caused by a sudden change in Load or an Energy Producing System, the switching of a Network element, tapping of transformers and other types of faults.]
system strength requirements	The meaning given in the *WEM Rules*. [Note: The definition in Chapter 11 of the consolidated companion version of the *WEM Rules*, dated 22 July 2023, was: **System Strength Requirements**: Means, the requirements identified to maintain sufficient System Strength on the SWIS, as determined by the processes specified in the WEM Procedure referred to in clause 3.2.7.]
tap-changing transformer	A *transformer* with the capability to allow internal adjustment of output *voltages* which can be automatically or manually initiated while on-line and which is used as a major component in the control of the *voltage* of the *transmission and distribution systems* in conjunction with the operation of *reactive* equipment. The *connection point* of a *generating unit* may have an associated *tap-changing transformer*, usually provided by the *Generator*. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
target setpoint	The meaning given in the *WEM Rules*. [Note: The definition in Appendix 12 of the consolidated companion version of the *WEM Rules*, dated 22 July 2023, was: **Target Setpoint**: Means a value specifying a desired operating level for the Generating Unit or Generating System, as applicable, at the relevant location. For example, a desired Active Power, Reactive Power or Power Factor.]
technical envelope	The limits described in the *WEM Rules*.
technical requirement	Each technical requirement for a *generating system* specified in section 3.3.7 of these *Rules*. [Note: This definition is different from the equivalent definition in Chapter 11 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]

temperature dependency data	The meaning given in the *WEM Rules*. [Note: The definition in Appendix 12 of the consolidated companion version of the *WEM Rules*, dated 22 July 2023, was: **Temperature Dependency Data:** Means a set of data defining the maximum achievable Active Power of a Generating System or Generating Unit at a particular temperature at the Measurement Location. The data will be provided based on a template provided by the Network Operator. The data shows the Active Power capability achievable for a range of ambient temperatures while meeting all other Technical Requirements.]
terminal station	A *substation* that transforms electricity between two *transmission system voltages* and that supplies electricity to *zone substations* but that does not *supply* electricity to the *distribution system*.
total fault clearance time	The time from fault inception to the time of complete fault interruption by a circuit breaker or circuit breakers. This is to be taken, as a minimum, to be equal to 10 milliseconds plus the circuit breaker maximum break time plus the maximum *protection* operating time. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
transfer capacity	System capacity from adjacent *demand groups* that can be made available within the times stated in Table 2-10.
transformer	A piece of equipment that reduces or increases the *voltage* of alternating current. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
transformer tap position	Where a tap changer is fitted to a *transformer*, each tap position represents a *change* in *voltage* ratio of the *transformer* which can be manually or automatically adjusted to *change* the *transformer* output *voltage*. The tap position is used as a reference for the output *voltage* of the *transformer*.
transmission	The functions performed by a *transmission system*, including conveying, transferring or permitting the passage of electricity.
transmission and distribution systems	The *Network Service Provider's transmission system* and *distribution system* collectively.
transmission capacity	The ability of the *transmission system* to transmit electricity. It does not include any ability resulting from operational measures.
transmission circuit	Part of the *transmission system* between two or more circuit breakers, which may include overhead lines, underground cables, and bus tie *transformers* but excludes *busbars* and *generation circuits*.
transmission connected market generators	A *User* who is registered as a Market Generator in accordance with the *WEM Rules* and is responsible for a *generating system* that is *connected* to the *transmission system.*

transmission element	A single identifiable major component of a *transmission system* involving: (a) an individual *transmission circuit* or a phase of that circuit; or (b) a major item of *transmission* equipment necessary for the functioning of a particular *transmission circuit* or *connection point* (such as a *transformer* or a circuit breaker).
transmission equipment	The equipment associated with the function or operation of a *transmission circuit* or *substation*, which may include *transformers*, circuit breakers, *busbar*, *reactive equipment*, *monitoring equipment* and control *equipment*.
transmission line	A power line that is part of a *transmission system*.
transmission network adequacy	The ability of the *transmission* network to maintain transfer of electricity in compliance with section 2.5 of these *Rules*. When these conditions are met, the *transmission* network is deemed adequate.
Transmission Network Operator	The *Network Service Provider* personnel, systems and infrastructure that perform operational roles and responsibilities that provide for the safe, secure and reliable operation of the *transmission system.*
transmission or distribution system	Either the *Network Service Provider's transmission system* or *distribution system*.
transmission system	Any apparatus, equipment, plant or buildings used, or to be used, for, or in connection with, the transportation of electricity at nominal *voltages* of 66 kV or higher, and which forms part of the *South West Interconnected Network*. For the avoidance of doubt the *transmission system* includes equipment such as static *reactive power* compensators, which are operated at *voltages* below 66 kV, provided that the primary purpose of this equipment is to support the transportation of *electricity* at *voltages* of 66 kV or higher. [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
transmission system planning criteria	The criteria set out in section 2.5 of these *Rules* in accordance with the requirement under section A6.1(m) of the *Access Code*.
trigger event	One or more circumstances specified in a *negotiated generator performance standard*, the occurrence of which requires a *Generator* responsible a *large generating system* to undertake required actions to achieve an agreed outcome and or achieve an agreed higher level of performance than the existing *registered generator performance standard* applicable in respect of one or more technical requirements.
trip circuit supervision	A function incorporated within a *protection scheme* that results in alarming for the loss of integrity of the *protection scheme's* trip circuit. *Trip circuit supervision* supervises a *protection scheme*'s trip supply together with the integrity of associated wiring, cabling and circuit breaker trip coil.
trip supply supervision	A function incorporated within a *protection scheme* that results in alarming for loss of trip supply.

turbine control system	The automatic control system that regulates the speed and power output of a *generating unit* through the control of the rate of entry into the *generating unit* of the primary *energy* input (for example, steam, gas or water). [Note: This definition is used in Appendix 12 of the consolidated companion version of the *WEM Rules* dated 22 July 2023.]
two fully independent protection schemes	*Protection schemes* having differing principles of operation and which, in combination, provide dependable detection of faults on the protected *primary equipment* and operate within a specified time, despite any single failure to operate of the *secondary equipment*. To achieve this, complete *secondary equipment* redundancy is required, including *current transformer* and *voltage transformer* secondaries, auxiliary supplies, signalling systems, cabling, wiring, and circuit breaker trip coils. Auxiliary supplies include DC supplies for *protection* purposes. Therefore, to satisfy the redundancy requirements, each *protection scheme* would need to have its own independent battery and battery charger system supplying all that *protection scheme*'s trip functions. In addition, the relays of each *protection scheme* must be grouped in separate physical locations (which need not be in different panels). Furthermore, the two *protection schemes* must either use different methods of operation or, alternatively, have been designed and manufactured by different organisations.
UFLS Specification Document	The document developed in accordance with clause 3.6.6 of the *WEM Rules.*
unacceptable frequency conditions	The conditions where the system *frequency* falls outside of the limits specified in the *WEM Rules*.
unacceptable overloading	The overloading of any *primary equipment* beyond its specified time-related capability, with consideration for specific conditions (e.g., ambient/seasonal temperature), pre-fault loading, time-dependent loading cycles of equipment and any additional relevant procedures. In operational timeframes, dynamic ratings may also be used where available.
unacceptable voltage conditions	The conditions where *voltage* falls outside of the limits specified in clause 2.2.2 or 2.2.3 of these *Rules*.
unplanned outage	An *outage* of one or more items of equipment, which may include *User* or *Network Service Provider* equipment, initiated by manually instructed action that has not been subject to an *outage* process managed by the *Network Service Provider* or *AEMO*.
User	The meaning given in clause 1.3(b)(3) of these *Rules*.
User operating protocol	A document that captures the operational arrangements between a *User* and the *Network Service Provider*.
voltage	The electronic force or electric potential between two points that gives rise to the flow of electricity.

voltage stability	The ability of a *power system* to attain steady *voltages* at all *busbars* after being subjected to a disturbance from a given operating condition. Instability that may result occurs in the form of a progressive fall or rise of *voltages* at some *busbars*. Possible outcomes of *voltage* instability are loss of *load* in an area, or the tripping of *transmission lines* and other elements, including *generating units*, by their protective systems leading to *cascading outages*.
voltage step change	The difference in *voltage* between that immediately before a *contingency event* or operational switching and that at the end of the transient time phase after the event. Measured as the differences between: (a) the post-event *voltage* appearing once the transient response has subsided but prior to control actions taken to restore *voltage* such as adjustment of *transformer tap position* via on-load tap changers, and (b) the pre-event *voltage* measures just prior to the event occurring.
voltage transformer (VT)	A *transformer* for use with meters and/or *protection* devices in which the *voltage* across the secondary terminals is, within prescribed error limits, proportional to and in phase with the *voltage* across the primary terminals.
WA Electrical Requirements	The WA Electrical Requirements issued under Regulation 49 of the *Electricity (Licensing) Regulations 1991* (WA).
WA Service and Installation Requirements	The Western Australia Service and Installation Requirements as published by Western Power and Horizon Power.
weak infeed fault conditions	Occur when a *generating unit connected* to the *distribution system* supplies a fault current that is significantly below normal *load* current of the installed *transmission protection scheme.*
WEM Rules	The Wholesale Electricity Market Rules established under the *Electricity Industry (Wholesale Electricity Market) Regulations 2004 (WA)*.
Wholesale Electricity Market (WEM)	The meaning given in the *WEM Rules*. [Note: The definition in Chapter 11 of the consolidated companion version of the *WEM Rules*, dated 22 July 2023, was: **Wholesale Electricity Market:** The market established under section 122 of the Electricity Industry Act.]
wind farm	A *power station* consisting of one or more wind powered *generating units*.
written law	The meaning given to it in section 5 of the *Interpretation Act 1984* (WA).
zone substation	A *substation* that transforms electricity from a *transmission system voltage* to a *distribution system voltage*.

ATTACHMENT 2 INTERPRETATION

In these *Rules*, headings and captions are for convenience only and do not affect interpretation and, unless the contrary intention appears from the context, and subject to the *Act* and the *Access Code*, these *Rules* must be interpreted in accordance with the following rules of interpretation:

(a) a reference in these *Rules* to a contract or another instrument includes a reference to any amendment, variation or replacement of it save for a reference to an *Australian Standard* that explicitly states a date or year of publication;

(b) a reference to a person includes a reference to the person's executors, administrators, successors, substitutes (including persons taking by novation) and assigns;

(c) references to time are to Western Standard Time, being the time at the 120th meridian of longitude east of Greenwich in England, or Coordinated Universal Time, as required by the *National Measurement Act 1960* (Cth);

(d) any calculation must be performed to the accuracy, in terms of a number of decimal places, determined by the *Network Service Provider* in respect of all *Users*;

(e) where any word or phrase is given a defined meaning, any part of speech or other grammatical form of that word or phrase has a corresponding meaning;

(f) the word "including" means "including, but without limiting the generality of the foregoing" and other forms of the verb "to include" are to be construed accordingly;

(g) a connection point is a User's connection point or a connection point of a User if it is the subject of a connection agreement between the User and the Network Service Provider;

(h) a reference to a half hour is a reference to a 30 minute period ending on the hour or on the half hour and, when identified by a time, means the 30 minute period ending at that time; and

(i) measurements of physical quantities are in Australian legal units of measurement within the meaning of the *National Measurement Act 1960* (Cth).

ATTACHMENT 3 SCHEDULES OF TECHNICAL DETAILS IN SUPPORT OF CONNECTION APPLICATIONS

A3.1. Various sections of the *Rules* require that *Users* submit technical data to the *Network Service Provider*. This Attachment 3 summarises schedules listing the typical range of data that may be required and explains the terminology. Data additional to those listed in the schedules may be required. The actual data required will be advised by the *Network Service Provider* at the time of assessment of a *transmission* or *distribution system access application* and will form part of the technical specification in the *access contract* or *connection agreement*.

A3.2. Data is categorised according to the stage at which it is available in the build-up of data during the process of forming a connection or obtaining *access* to a *transmission or distribution system*, with data acquired at each stage being carried forward, or enhanced in subsequent stages, e.g. testing.

Preliminary system planning data

This is data required for submission with the *access application* or connection application, to allow the *Network Service Provider* to prepare an offer of terms for a *connection agreement* and to assess the requirement for, and effect of, *transmission and distribution system augmentation* or *extension* options. Such data is normally limited to the items denoted as Standard Planning Data (S) in the technical data schedules in Attachment 4 to Attachment 10.

The *Network Service Provider* may, in cases where there is doubt as to the viability of a proposal, require the submission of other data before making an *access* offer to connect or to amend an *access contract* or *connection agreement*.

Registered system planning data

This is the class of data that will be included in the *access contract* or *connection agreement* signed by both parties. It consists of the preliminary system planning data plus those items denoted in the attached schedules as Detailed Planning Data (D). The latter must be submitted by the *User* in time for inclusion in the *access contract* or *connection agreement*.

Registered Data

Registered Data (R) consists of data validated and augmented prior to actual connection and provision of access from manufacturers' data, detailed design calculations, works or site tests etc.(R1); and data derived from on-system testing after connection (R2).

All of the data will, from this stage, be categorised and referred to as Registered Data; but for convenience the schedules omit placing additional category identifiers against items that are expected to already be valid at an earlier stage.

A3.3. Data will be subject to review at reasonable intervals to ensure its continued accuracy and relevance. The *Network Service Provider* must initiate this review. Subject to complying with obligations in Chapters 3 and 4 requiring the *User* to gain approval for setting changes from the *Network Service Provider*, a *User* may *change* any data item at any time. Revised data must be submitted to the *Network Service Provider*, together with authentication documents and supporting reports.

A3.4. Attachment 4 to Attachment 12, cover the following data areas:

(a) Attachment 4 – LARGE *GENERATING SYSTEM* DESIGN DATA. This comprises large *generating systems* fixed design parameters.

(b) Attachment 5 - SUBMISSION REQUIREMENTS FOR ELECTRICAL PLANT *PROTECTION*. This comprises design and setting data for *protection systems* that must coordinate or interface with the *protection systems* for the *transmission and distribution system* or that could impact the operation of the *transmission and distribution system*.

(c) Attachment 6 – LARGE *GENERATING UNIT OR GENERATING SYSTEM* SETTING DATA. This comprises settings which can be varied by agreement or by *direction* of the *Network Service Provider*.

(d) Attachment 7 - *TRANSMISSION SYSTEM* AND EQUIPMENT TECHNICAL DATA OF EQUIPMENT AT OR NEAR *CONNECTION POINT*. This comprises fixed electrical parameters.

(e) Attachment 8 - *TRANSMISSION SYSTEM EQUIPMENT* AND APPARATUS SETTING DATA. This comprises settings which can be varied by agreement or by *direction* of the *Network Service Provider*.

(f) Attachment 9 - *LOAD* CHARACTERISTICS AT *CONNECTION POINT*. This comprises the estimated parameters of *load* groups in respect of, for example, harmonic content and response to *frequency* and *voltage* variations.

(g) Attachment 10 - SMALL *GENERATING SYSTEM* DESIGN AND SETTING DATA (RATED CAPACITY ≤ 5 MVA EXCLUDING *INVERTER ENERGY SYSTEMS CONNECTED* TO THE *LOW VOLTAGE DISTRIBUTION SYSTEM* VIA A *STANDARD CONNECTION SERVICE*). This comprises a reduced set of design parameters that the *Network Services Provider* may require for small *power stations* covered by clause 3.6 and 3.7 of the *Rules*.

(h) Attachment 11 –TEST SCHEDULE FOR SPECIFIC PERFORMANCE VERIFICATION AND MODEL VALIDATION. This comprises a schedule of commissioning and performance tests that the *Network Service Provider* may require for large *generating units* covered by clause 3.3 and specified in Chapter 4 of the *Rules*.

(i) Attachment 12 – TESTING AND COMMISSIONING OF SMALL *POWER STATIONS CONNECTED* TO THE *DISTRIBUTION SYSTEM*. This comprises a schedule of commissioning and performance tests that the *Network Service Provider* may require for small *power stations* covered by clause 3.6 and 3.7 of the *Rules*.

A3.5. A *Generator* that connects a large *generating unit* that is not a *synchronous generating unit* must be given exemption from complying with those parts of schedules in Attachment 4 and Attachment 6 that are determined by the *Network Service Provider* to be not relevant to such *generating units*, but must provide the information required by those parts of the schedules in Attachments 5, 7, 8 and 9 that are relevant to such *generating units*, as determined by the *Network Service Provider*. For *asynchronous generating units*, additional data may be requested by the *Network Service Provider*.

Codes:

S = Standard Planning Data

D = Detailed Planning Data

R = Registered Data (R1 pre-*connection*, R2 post-*connection*)

ATTACHMENT 4 LARGE *GENERATING SYSTEM* DESIGN DATA[1]

Symbol	Data Description	Units	Data Category
	***Power station* technical data:**		
	Connection point to *transmission system*	Text, diagram	S, D
	Nominal *voltage* at *connection point* to *transmission system*	kV	S
	Total *Power Station* Sent Out Capacity	MW (sent out)	S, D, R2
	At *connection point*:		
MSCR	Minimum *Short Circuit Ratio*: The lowest *short circuit ratio* at the *connection point* for which the *generating system*, including its control systems: (i) will be commissioned to maintain stable operation; and (ii) has the design capability to maintain stable operation. For the purposes of the above, "*short circuit ratio*" is the synchronous three phase fault level (expressed in MVA) at the *connection point* divided by the rated output of the *generating system* (expressed in MW or MVA) at the *Network Service Provider's* discretion.	Numeric ratio	S, D, R1
	Maximum 3 phase short circuit infeed calculated by method of *AS* 3851 (1991) (Amendment 1-1992):		
	Symmetrical	kA	S, D
	Asymmetrical	kA	D
	Minimum zero sequence impedance	(a+jb) ohms	D
	Minimum negative sequence impedance	(a+jb) ohms	D

Symbol	Data Description	Units	Data Category
	Controllers responding to *frequency* deviations (e.g. generating unit turbine controller, generating unit or generating system load controller)		
	Make	Text	S, D
	Model	Text	S, D
	General description of *turbine control system* or other control systems that adjusts *active power generated* to correct *power system frequency* deviations (including block diagram transfer function & parameters)	Text, diagram	S, D
	Maximum Droop	%	S, D, R1
	Normal Droop	%	D, R1
	Minimum Droop	%	D, R1
	Maximum *Frequency* Dead band	Hz	D, R1
	Normal *Frequency* Dead band	Hz	D, R1
	Minimum *Frequency* Dead band	Hz	D, R1
	MW Dead band	MW	D, R1
	***Generating unit* or *generating system* response capability:**		
	Sustained response to *frequency change*	MW/Hz	D, R2
	Non-sustained response to *frequency change*	MW/Hz	D, R2
	Load Rejection Capability	MW	S, D, R2
	Individual *synchronous generating unit* data:		
	Make		
	Model		
MBASE	Rated MVA	MVA	S, D, R1
PSO	Rated MW (Sent Out)	MW (sent out)	S, D, R1
PMAX	Rated MW (*generated*)	MW (Gen)	D

Symbol	Data Description	Units	Data Category
VT	Nominal Terminal *Voltage*	kV	D, R1
PAUX	Auxiliary *load* at PMAX	MW	S, D, R2
Qmax	Rated Reactive Output at PMAX	Mvar (sent out)	S, D, R1
PMIN	Minimum *Load* (ML)	MW (sent out)	S, D, R2
H	Inertia Constant for all rotating masses *connected* to the *generating unit* shaft (for example, *generating unit*, turbine, etc.)	MWs/rated MVA	S, D, R1
Hg	*Generating unit* Inertia Constant (applicable to *synchronous condenser* mode of operation)	MWs/rated MVA	S, D, R1
GSCR	*Short Circuit Ratio*		D, R1
ISTATOR	Rated Stator Current	A	D, R1
IROTOR	Rated Rotor Current at rated MVA and *Power factor*, rated terminal volts and rated speed	A	D, R1
VROTOR	Rotor *Voltage* at which IROTOR is achieved	V	D, R1
VCEIL	Rotor *Voltage* capable of being supplied for five seconds at rated speed during field forcing	V	D, R1
ZN	Neutral Earthing Impedance	(a+jb)%* * MVA base must be clearly stated.	
	***Generating unit* resistance:**		
RA	Stator Resistance	% on MBASE	S, D, R1, R2
RF	Rotor resistance at 20°C	ohms	D, R1
	***Generating unit* sequence impedances (saturated):**		
Z0	Zero Sequence Impedance	(a+jb)% on MBASE	D, R1
Z2	Negative Sequence Impedance	(a+jb)% on MBASE	D, R1
	***Generating unit* reactances (saturated):**		
XD'(sat)	Direct Axis Transient Reactance	% on MBASE	D, R1

Symbol	Data Description	Units	Data Category
XD"(sat)	Direct Axis Sub-Transient Reactance	% on MBASE	D, R1
	***Generating unit* reactances (unsaturated):**		
XD	Direct Axis Synchronous Reactance	% on MBASE	S, D, R1, R2
XD'	Direct Axis Transient Reactance	% on MBASE	S, D, R1, R2
XD"	Direct Axis Sub-Transient Reactance	% on MBASE	S, D, R1, R2
XQ	Quadrature Axis Synch Reactance	% on MBASE	D, R1, R2
XQ'	Quadrature Axis Transient Reactance	% on MBASE	D, R1, R2
XQ"	Quadrature Axis Sub-Transient Reactance	% on MBASE	D, R1, R2
XL	Stator Leakage Reactance	% on MBASE	D, R1, R2
XO	Zero Sequence Reactance	% on MBASE	D, R1
X2	Negative Sequence Reactance	% on MBASE	D, R1
XP	Potier Reactance	% on MBASE	D, R1
	***Generating unit* time constants (unsaturated):**		
TDO'	Direct Axis Open Circuit Transient	Seconds	S, D, R1, R2
TDO"	Direct Axis Open Circuit Sub-Transient	Seconds	S, D, R1, R2
TKD	Direct Axis Damper Leakage	Seconds	D, R1, R2
TQO'	Quadrature Axis Open Circuit Transient	Seconds	D, R1, R2
TA	Armature Time Constant	Seconds	D, R1, R2
TQO"	Quadrature Axis Open Circuit Sub-Transient	Seconds	D, R1, R2
	Charts:		
GCD	*Generator performance chart*	Graphical data	D, R1, R2
GOCC	Open Circuit Characteristic	Graphical data	R1
GSCC	Short Circuit Characteristic	Graphical data	R1
GZPC	Zero *power factor* curve	Graphical data	R1
	V curves	Graphical data	R1

Symbol	Data Description	Units	Data Category
GOTC	MW, Mvar outputs versus temperature chart	Graphical data	D, R1, R2
	Generating unit transformer:		
GTW	Number of windings	Text	S, D
GTRn	Rated MVA of each winding	MVA	S, D, R1
GTTRn	Principal tap rated *voltages*	kV/kV	S, D, R1
GTZ1n	Positive Sequence Impedances (each wdg)	(a + jb) % on 100 MVA base	S, D, R1
GTZ2n	Negative Sequence Impedances (each wdg)	(a + jb) % on 100 MVA base	S, D, R1
GTZOn	Zero Sequence Impedances (each wdg)	(a + jb) % on 100 MVA base	S, D, R1
	Tapped Winding	Text, diagram	S, D, R1
GTAPR	Tap Change Range	kV - kV	S, D
GTAPS	Tap Change Step Size	%	D
	Tap Changer Type, On/Off *load*	On/Off	D
	Tap Change Cycle Time	Seconds	D
GTVG	Vector Group	Diagram	S, D
	Earthing Arrangement	Text, diagram	S, D
	Saturation curve	Diagram	R1
	***Generating unit* reactive capability (at machine terminals):**		
	Lagging *Reactive power* at PMAX	Mvar export	S, D, R2
	Lagging *Reactive power* at ML	Mvar export	S, D, R2
	Lagging Reactive Short Time	Mvar	D, R1, R2
	capability at rated MW, terminal	(for time)	
	Voltage and speed		
	Leading *Reactive power* at rated MW	Mvar import	S, D, R2

Symbol	Data Description	Units	Data Category
	***Generating unit excitation control system*:**		
	Make		
	Model		
	General description of *excitation control system* (including block diagram transfer function & parameters)	Text, diagram	S, D
	Rated Field *Voltage* at rated MVA and *Power factor* and rated terminal volts and speed	V	S, D, R1
	Maximum Field *Voltage*	V	S, D, R1
	Minimum Field *Voltage*	V	D, R1
	Maximum rate of change of Field *Voltage*	Rising V/s	D, R1
	Maximum rate of change of Field *Voltage*	Falling V/s	D, R1
	Generating unit and exciter Saturation		
	Characteristics 50 - 120% V	Diagram	D, R1
	Dynamic Characteristics of Over	Text	
	Excitation Limiter (drawn on capability *generating unit* diagram)	Block diagram	D, R2
	Dynamic Characteristics of Under	Text	
	Excitation Limiter (drawn on capability *generating unit* diagram)	Block diagram	D, R2
	Mechanical shaft model:		
	(Multiple-stage steam turbine *generating units* only)		
	Dynamic model of turbine/*generating unit* shaft system in lumped element form showing component inertias, damping and shaft stiffness.	Diagram	D
	Natural damping of shaft torsional oscillation modes (for each mode)		
	- Modal *frequency*	Hz	D
	- Logarithmic decrement	Nepers/Sec	D

Symbol	Data Description	Units	Data Category
	Steam Turbine Data:		
	(Multiple-stage steam turbines only)		
	Fraction of power produced by each stage:		
	Symbols KHP KIP KLP1 KLP2	Per unit of Pmax	D
	Stage and reheat time constants:		
	Symbols THP TRH TIP TLP1 TLP2	Seconds	D
	Turbine *frequency* tolerance curve	Diagram	S, D, R1
	Gas turbine data		
HRSG	Waste heat recovery boiler time constant (where applicable e.g. for co-generation equipment)	Seconds	D
	MW output versus turbine speed (47-52 Hz)	Diagram	D, R1, R2
	Type of turbine (heavy industrial, aero derivative etc.)	Text	S
	Number of shafts		S, D
	Gearbox Ratio		D
	Fuel type (gas, liquid)	Text	S, D
	Base *load* MW vs temperature	Diagram	D
	Peak load MW vs temperature	Diagram	D
	Rated exhaust temperature	°C	S, D
	Controlled exhaust temperature	°C	S, D, R1
	Turbine *frequency* tolerance capability	Diagram	D
	Turbine compressor surge map	Diagram	D

Symbol	Data Description	Units	Data Category
	Hydraulic turbine data		
	Required data will be advised by the *Network Service Provider*		
	***Wind farm*/wind turbine data**[1]		
	A typical 24 hour power curve measured at 15-minute intervals or better if available;		S, D, R1
	maximum kVA output over a 60 second interval		S, D, R1
	Data on power quality characteristics for wind *Generators* (including flicker and harmonics) as specified in IEC 61400-21.		
	Long-term flicker factor for *generating unit*		S, D, R1
	Long term flicker factor for *wind farm*		S, D, R1
	Maximum output over a 60 second interval	kVA	S, D, R1
	Harmonics current spectra	A	S, D, R1
	Power curve MW vs. wind speed	Diagram	D
	Spatial Arrangement of *wind farm*	Diagram	D
	Startup profile MW, Mvar vs time for individual Wind Turbine Unit and *Wind farm* Total	Diagram	D
	Low Wind Shutdown profile MW, Mvar vs time for individual Wind Turbine Unit and *Wind farm* Total	Diagram	D
	MW, Mvar vs time profiles for individual Wind Turbine Unit under normal ramp up and ramp down conditions.	Diagram	D
	High Wind Shutdown profile MW, Mvar vs time for individual Wind Turbine Unit and *Wind farm* Total	Diagram	D
	Induction *generating unit* data		
	Make		
	Model		
	Type (squirrel cage, wound rotor, doubly fed)		

Symbol	Data Description	Units	Data Category
MBASE	Rated MVA	MVA	S, D, R1
PSO	Rated MW (Sent out)	MW	S, D, R1
PMAX	Rated MW (*generated*)	MW	D
VT	Nominal Terminal *Voltage*	kV	S, D, R1
	Synchronous Speed	rpm	S, D, R1
	Rated Speed	rpm	S, D, R1
	Maximum Speed	rpm	S, D, R1
	Rated *Frequency*	Hz	S, D, R1
Qmax	Reactive consumption at PMAX	Mvar import	S, D, R1
	Curves showing torque, *power factor*, efficiency, stator current, MW output versus slip (+ and -).	Graphical data	D, R1, R2
	Number of *capacitor banks* and Mvar size at rated *voltage* for each *capacitor bank* (if used).	Text	S
	Control philosophy used for var /*voltage* control.	Text	S
H	Combined inertia constant for all rotating masses *connected* to the *generating unit* shaft (for example, *generating unit*, turbine, gearbox, etc.) calculated at the synchronous speed	MW-sec/MVA	S, D, R1
	Resistance		
Rs	Stator resistance	% on MBASE	D, R1
Rs	Stator resistance versus slip curve, or two extreme values for zero (nominal) and unity (negative) slip	Graphical data or % on MBASE	D, R1
	Reactances (saturated)		
X'	Transient reactance	% on MBASE	D, R1
X''	Subtransient reactance	% on MBASE	D, R1
	Reactances (unsaturated)		
X	Sum of magnetising and primary winding leakage reactance.	% on MBASE	D, R1

Symbol	Data Description	Units	Data Category
X'	Transient reactance	% on MBASE	D, R1
X''	Subtransient reactance	% on MBASE	D, R1
Xl	Primary winding leakage reactance	% on MBASE	D, R1
	Time constants (unsaturated)		
T'	Transient	sec	S, D, R1, R2
T''	Subtransient	sec	S, D, R1, R2
Ta	Armature	sec	S, D, R1, R2
To'	Open circuit transient	sec	S, D, R1, R2
To''	Open circuit subtransient	sec	S, D, R1, R2
	Converter data		
	Control: *transmission system* commutated or self commutated Additional data may be required by the *Network Service Provider*		
	Doubly fed induction *generating unit* data		
	Required data will be advised by the *Network Service Provider*		
	***Inverter connected generating systems*[2]**		
	Generating System Identifier[3]	text	S
	Make	text	D
	Model	text	D
	Maximum *apparent power* output over a 60 s interval[4]	MVA	S, D, R1
	Maximum fault current contribution[4]	kA rms symmetrical	S, D, R1
	Control modes (*voltage, reactive power, power factor*)[4]	Text	S, D, R1
	Attachments		

Symbol	Data Description	Units	Data Category
	Control system block diagram including limiters and parameters for *voltage*, *reactive power*, *power factor* controls	Graphical Data	S, D, R1
	Block diagram including limiters and parameters for power oscillation damper	Graphical Data	S, D, R1
	Reactive capability curve	Graphical Data	S, D, R1
	Data on power quality characteristics including flicker and harmonics similar to that specified in IEC 61400-21.		
	Long-term flicker factor for *Generator*		S, D, R2
	Long term flicker factor for *wind farm*		S, D, R2
	Harmonics current spectra		S, D, R2
	The *Network Service Provider* may specify additional data for *inverter energy systems*		

Notes:

1: Where applicable and unless requested otherwise, the data shall be provided at the site specific maximum ambient temperature.

2: A separate data sheet is required for each *generating unit* within the *generating system*.

3: Where there is more than one *generating unit*, the identifier should be the same as used on the single line diagram.

4: Aggregate capability for the entire *generating system*

ATTACHMENT 5SUBMISSION REQUIREMENTS FOR ELECTRICAL PLANT *PROTECTION*

Protection **data submission timelines:**		
D	Within 3 *months* of signing of the *connection agreement*, or as agreed otherwise in the *connection agreement*.	
R1	At least 3 *months* prior to commencement of *protection* equipment commissioning, or as agreed otherwise in the *connection agreement*.	
R2	Within 3 weeks of the completion of *protection equipment* commissioning, or as agreed otherwise in the *connection agreement*.	
Data Description		Data Category
Protection **Design Philosophy:**		
Documentation explaining the general *protection* philosophy, including:		D, R1 and R2
	- Present and design minimum and maximum fault levels.	
	- Present and design minimum and maximum fault contributions to the network from the *User*, at the *connection point*.	
	- Details of required *critical fault clearance times*, and which *protections* will be employed to meet these times.	
	- Local Back-up (*circuit breaker fail*) philosophy.	
	- Special scheme philosophy (for example, islanding or *load shedding* schemes).	
	- *Protection* number 1 philosophy	
	- *Protection* number 2 philosophy	
Power single line diagram, down to and including the *low voltage* (greater than 50V AC) bus(s), including:		D, R1 and R2
	- *Voltage* levels,	
	- *Transformer* ratings, winding configurations and earthing connections	
	- *Generating unit* ratings and earthing connections	
	- Operating status of switching devices	
	- Earthing configuration	

	- Primary plant interlocks	
Details of *protection* interfaces between the network and the *User*		D, R1 and R2
Protection single line diagram, down to and including the *low voltage* (greater than 50V AC) bus(s), including:		R1 and R2
	- *Current transformer* locations, rated primary and secondary current, rated short-time thermal current, rated output, accuracy class and designation.	
	- *Voltage transformer* locations, winding connections, rated primary and secondary *voltage*s, rated output and accuracy class.	
	- Relay make and model number	
	- Relay functions employed	
	- Primary plant mechanical *protection*s	
	- Trip details (diagrammatic or by trip matrix)	
Impedance diagram of the system, showing, for each item of primary plant, details of the positive, negative and zero sequence series and shunt impedances, including mutual coupling between physically adjacent elements. Impedances to be in per unit, referred to a 100MVA base. Final submission (R2) to include tested values of *generating unit* and *transformer* impedances (for example, from manufacturer's test certificates)		R1 and R2
Tripping and control power *supply* (e.g. DC system) single line diagram.		R1 and R2
Power flow details at the *connection point* as per the data requested in Attachment 5.		R1 and R2
HV circuit breaker details, including:		R1 and R2
	- A control and *protection* schematic diagram of the circuit breaker(s) at the *User* connection to the network	
	- Type, rated current and rated fault MVA or rated breaking current of all *HV* circuit breakers	
HV switch fuse details, including:		R1 and R2
	- Rated current of fuse	
	- Rated breaking current of fuse	
	- Type of fuse	

	- Current-time characteristic curves	
***Protection* Settings Design Philosophy:**		
Documentation explaining the general *protection* settings philosophy		R1 and R2
Calculated *critical fault clearance times*		R1 and R2
Protection function settings to be employed and reasons for selecting these settings. Diagrams to be submitted where applicable.		R1 and R2
Overcurrent grading curves for phase faults.		R1 and R2
Overcurrent grading curves for earth faults		R1 and R2

ATTACHMENT 6 LARGE *GENERATING UNIT OR GENERATING SYSTEM* SETTING DATA

Data Description Category	Units	Data
***Protection* Data:**		
Settings of the following *protection*s:		
Loss of field	Text	D
Under excitation	Text, diagram	D
Over excitation	Text, diagram	D
Differential	Text	D
Under *frequency*	Text	D
Over *frequency*	Text	D
Negative sequence component	Text	D
Stator overvoltage	Text	D
Stator overcurrent	Text	D
Rotor overcurrent	Text	D
Reverse power	Text	D
Control Data:		
Details of *excitation control system* incorporating, where applicable, individual elements for *power system* stabiliser, under excitation limiter and over excitation limiter described in block diagram form showing transfer functions of individual elements, parameters and measurement units (preferably in IEEE format, but suitable for use in the software package nominated by the *Network Service Provider*. Currently, that package is DigSilent): The source code of the model must also be provided, in accordance with clause 3.3.11.	Text, diagram	D, R1, R2
Settings of the following controls:		
Details of the *turbine control system* described in block diagram form showing transfer functions of individual elements and measurement units (preferably in IEEE format, but suitable for use in the software package nominated by the *Network Service Provider*. Currently, that package is DigSilent).The source code of the model must also be provided, in accordance with clause 3.3.11.	Text, diagram	D, R1, R2
Stator current limiter (if fitted)	Text, diagram	D
Manual restrictive limiter (if fitted)	Text	D
Load drop compensation/var sharing (if fitted)	Text, function	D
V/f limiter (if fitted)	Text, diagram	D

ATTACHMENT 7 *TRANSMISSION SYSTEM* AND EQUIPMENT TECHNICAL DATA OF EQUIPMENT AT OR NEAR *CONNECTION POINT*

Data Description Category	Units	Data
***Voltage* rating**		
Nominal *voltage*	kV	S, D
Highest *voltage*	kV	D
Insulation co-ordination		
Rated lightning impulse withstand *voltage*	kVp	D
Rated short duration power *frequency* withstand *voltage*	kV	D
Rated currents		
Circuit maximum current	kA	S, D
Rated Short Time Withstand Current	kA for seconds	D
Ambient conditions under which above current applies	Text	S, D
Earthing		
System Earthing Method	Text	S, D
Earth grid rated current	kA for seconds	D
Insulation Pollution Performance		
Minimum total creepage	mm	D
Pollution level	Level of IEC 815	D
Controls		
Remote control and data transmission arrangements	Text	D

***Transmission system* configuration**		
Operation Diagrams showing the electrical circuits of the existing and proposed main *facilities* within the *User's* ownership including *busbar* arrangements, phasing arrangements, earthing arrangements, switching *facilities* and operating *voltages*.	Single line Diagrams	S, D, R1
***Transmission system* impedances**		
For each item of equipment (including lines): details of the positive, negative and zero sequence series and shunt impedances, including mutual coupling between physically adjacent elements.	% on 100 MVA base	S, D, R1
Short circuit infeed to the *transmission system*		
Maximum *Generating unit* 3-phase short circuit infeed including infeeds from *generating units connected* to the *User's* system, calculated by method of *AS* 3851 (1991)(Amndt 1-1992).	kA symmetrical	S, D, R1
The total infeed at the instant of fault (including contribution of induction motors).	kA	D, R1
Minimum zero sequence impedance of *User's transmission system* at *connection point*.	% on 100 MVA base	D, R1
Minimum negative sequence impedance of *User's transmission system* at *connection point*.	% on 100 MVA base	D, R1
***Load* transfer capability:**		
Where a *load*, or group of *loads*, may be fed from alternative *connection points*:		
Load normally taken from *connection point* X	MW	D, R1
Load normally taken from *connection point* Y	MW	D, R1
Arrangements for transfer under planned or fault *outage* conditions	Text	D

Circuits connecting embedded *generating units* to the *transmission system*:

For all *generating units*, all connecting lines/cables, *transformers* etc.

Series Resistance (+ve, -ve & zero seq.)	% on 100 MVA base	D, R
Series Reactance (+ve, -ve & zero seq.)	% on 100 MVA base	D, R
Shunt Susceptance (+ve, -ve & zero seq.)	% on 100 MVA base	D, R
Normal and short-time emergency ratings	MVA	D, R
Technical Details of *generating units* as per schedules S1, S2		

***Transformers* at *connection points*:**

Saturation curve	Diagram	R

ATTACHMENT 8 *TRANSMISSION SYSTEM EQUIPMENT* AND APPARATUS SETTING DATA

Description Category	Units	Data
***Protection* data for *protection* relevant to**		
Connection point:		
Reach of all *protection*s on *transmission lines*, or cables	ohms or % on 100 MVA base	S, D
Number of *protection*s on each item	Text	S, D
Total fault clearing times for near and remote faults	ms	S, D, R1
Line reclosure sequence details	Text	S, D, R1
Tap change control data:		
Time delay settings of all *transformer* tap changers.	Seconds	D, R1
Reactive compensation (including filter banks):		
Location and rating of individual *shunt reactors*	Mvar	D, R1
Location and rating of individual shunt *capacitor bank*s	Mvar	D, R1
Capacitor bank capacitance	microfarads	D
Inductance of switching *reactor* (if fitted)	millihenries	D
Resistance of capacitor plus *reactor*	Ohms	D
Details of special controls (e.g. Point-on-wave switching)	Text	D
For each *shunt reactor* or *capacitor bank* (including filter banks):		
Method of switching	Text	S
Details of automatic control logic such that operating characteristics can be determined	Text	D, R1

Description Category	Units	Data
FACTS Installation:		
Data sufficient to enable static and dynamic performance of the installation to be modelled	Text, diagrams control settings	S, D, R1
Under *frequency load shedding* scheme:		
Relay settings (*frequency* and time)	Hz, seconds	S, D
Islanding scheme:		
Triggering signal (e.g. *voltage*, *frequency*)	Text	S, D
Relay settings	Control settings	S, D

ATTACHMENT 9 *LOAD* CHARACTERISTICS AT *CONNECTION POINT*

Description Category	Units	Data
For all Types of *Load*		
Type of *Load* e.g. controlled rectifiers or large motor drives	Text	S
Rated capacity	MW, MVA	S
Voltage level	kV	S
Rated current	A	S
Power factor range during normal operation	Text/diagram	S
DC injection levels (for each phase)	A	S
For Fluctuating *Loads*		
Cyclic variation of *active power* over period	Graph MW/time	S
Cyclic variation of *reactive power* over period	Graph Mvar/time	S
Maximum rate of change of *active power*	MW/s	S
Maximum rate of change of *reactive power*	Mvar/s	S
Shortest Repetitive time interval between fluctuations in *active power* and *reactive power* reviewed annually	s	S
Largest step change in *active power*	MW	S
Largest step change in *reactive power*	Mvar	S
For commutating power electronic *load*:		
No. of pulses	Text	S
Maximum *voltage* notch	%	S
Harmonic current distortion (up to the 50th harmonic)	A or %	S

For *inverter connected large loads*

minimum *short circuit ratio* (MSCR)	The lowest *short circuit ratio* at the *connection point* for which the *load*, including its control systems: (i) will be commissioned to maintain stable operation; and (ii) has the design capability to maintain stable operation. For the purposes of the above, "*short circuit ratio*" is the synchronous three phase fault level (expressed in MVA) at the *connection point* divided by the rated consumption of the *load* (expressed in MW or MVA) at the *Network Service Provider*'s discretion.	numeric ratio	S, D, R1

ATTACHMENT 10 SMALL *GENERATING SYSTEM* DESIGN AND SETTING DATA (RATED CAPACITY ≤ 5 MVA EXCLUDING *INVERTER ENERGY SYSTEMS CONNECTED* TO THE *LOW VOLTAGE DISTRIBUTION SYSTEM* VIA A *STANDARD CONNECTION SERVICE*)

Power Station	**Data Category**
Address	S, R1
Description of *power station*, for example, is it a green or brownfield site, is there a process steam or heat requirement, any other relevant information	S
Site-specific issues which may affect access to site or design, e.g. other construction onsite, mine site, environmental issues, soil conditions	S, D
Number of *generating units* and ratings (kW)	S, D, R1
Type: e.g. synchronous, induction	S, D, R1
Manufacturer:	D
Connected to the network via: e.g. *inverter*, *transformer*, u/g cable etc.	S
Prime mover types: e.g. reciprocating, turbine, hydraulic, photovoltaic, other	S
Manufacturer	D
Energy source: e.g. natural gas, landfill gas, distillate, wind, solar, other	S
Total *power station* total capacity (kW)	S, D, R1
Power station export capacity (kVA)	S, D, R1
Forecast annual *energy generation* (kWh)	S, D
Normal mode of operation as per clause 3.1(e) i.e. (a) continuous parallel operation (b) occasional parallel operation (c) short term test parallel operation (d) bumpless transfer, ((1) rapid (2) gradual)	S
Purpose: e.g. power sales, peak lopping, demand management, exercising, emergency back up	S

Associated *Facility Load*	
Expected *peak load* at *facility* (kW)	S, D, R1
Forecast annual *energy* consumption (kWh)	S
Construction *supply* required?	S
Max construction power	S
Required connection date	S
Required full operation date	S
Expected life	S
Additional Information Required	
(1) proposed arrangement & site layout of the *power station* including prime movers, *generating units*, *transformers*, synchronising circuit breakers and lockable *disconnect* device. Each component should be identified so that the plan can be cross-referenced to the data provided.	S, D
(2) single line diagram & earthing configuration	S, D, R2
(3) details of *generating unit* or *generating system* maximum kVA output over 60 second interval	S, D, R2
(4) a typical 24 hour *load* power curve measured at 15 minute intervals or less	S, D. R2
(5) calculation of expected maximum symmetrical 3 phase fault current contribution	S, D,
(6) Data on power quality characteristics for *wind farms* (including flicker and harmonics) as specified in IEC 61400-21. Similar data may also be required for other *inverter connected generating systems* such as solar farms.	S, D, R2
(7) where required by the *Network Service Provider*, aggregate data required for performing stability studies undertaken in accordance with clause 2.3.5.2 and 2.3.6 and results of preliminary studies (if available)	D

Transformers[1]		
Item	**Unit**	**Data Category**
Identifier[2]		
Number of windings	Number	S
Rated MVA of each winding	MVA	S, D
Principal tap rated *voltages*	kV/kV	S
Positive sequence impedances (each wdg)[3]	(a+jb)%	D, R1
Negative sequence impedances (each wdg)[3]	(a+jb)%	D, R1
Zero sequence impedances (each wdg)[3]	(a+jb)%	D, R1
Tapped winding	Text or diagram	S
Tap change range	kV-kV	D
Tap change step size	%	D
Number of taps	Number	D
Tap changer type, on/off *load*	On/Off	S
Tap change cycle time	S	D
Vector group	Text or diagram	S
Attachments required		
Earthing arrangement		S, D

Notes:

1: A separate data sheet is required for each *transformer*.

2: Where there is more than one *transformer*, the identifier should be the same as used on the single line diagram.

3: Base quantities must be clearly stated.

***Synchronous generating systems*[1]**

Item	**Unit**	**Data Category**
Identifier[2]		
Make	Text	D
Model	Text	D
Rated kVA	kVA	S, D, R1
Nominal terminal *voltage*	kV	D
Number of pole-pairs	No	
Speed	rpm	
Rated kW (sent out)	kW (sent out)	S, D, R1
Minimum *load* (ML)	kW (sent out)	D, R1
Inertia constant (H) for *generating system* only	kW-sec/rated kVA	D, R1
Inertia constant (H) for all rotating masses *connected* to the *generating unit* shaft (for example, turbine, etc.). Include gearbox (if any)	kW-sec/rated kVA	D, R1
Short circuit ratio		D, R1
Neutral earthing impedance[3]	(a+jb)%	D, R1
Sequence Impedances (saturated)		
Zero sequence impedance[3]	(a+jb)%	D, R1
Negative sequence impedance[3]	(a+jb)%	D, R1
Reactances (saturated)		
Direct axis transient reactance[3]	%	D, R1
Direct axis sub-transient reactance[3]	%	D, R1
Reactive capability (at machine terminals)		
Maximum lagging (overexcited) *reactive power* at rated kW	kvar export	S, D, R2
Maximum leading (underexcited) *reactive power* at rated kW	kvar import	S, D, R2

Lagging reactive short time capability at rated kW, terminal *voltage* and speed	kvar for time	D, R1
Attachments		
Performance chart (Indicating effect of temperature and *voltage*)	Graphical data	S, D, R1

Notes:

1: A separate data sheet is required for each *generating unit*.

2: Where there is more than one *generating unit*, the identifier should be the same as used on the single line diagram.

3: Base quantities must be clearly stated

Induction *generating systems*[1]		
Item	**Unit**	**Data Category**
Identifier[2]		
Make	Text	D
Model	Text	D
Rated kVA	kVA	S, D, R1
Rated kW (sent out)	kW (sent out)	S, D, R1
Reactive consumption at rated kW	kvar	S, D, R1
Nominal terminal *voltage*	kV	D
Synchronous speed	rpm	D
Rated speed	rpm	D, R1
Maximum speed	rpm	D, R1
Rated *frequency*	Hz	D
Single or (effectively) double cage machine	Text	D, R1
***Generating system* reactances (saturated)**		
Transient reactance[2]	%	D, R1
Subtransient reactance[2]	%	D, R1
Control: network commutated or self commutated	Text	S, R1
Attachments		

Curves showing torque, *power factor*, efficiency, stator current, kW output versus slip (+ and -).	Graphical Data	S, D, R1
Notes: 1: A separate data sheet is required for each *generating unit*. 2: Where there is more than one *generating unit*, the identifier should be the same as used on the single line diagram. 3: Base quantities must be clearly stated.		

Inverter-connected generating systems[1]		
Item	**Unit**	**Data Category**
Identifier[2]		
Make	text	D
Model	text	D
Maximum kVA output over a 60 s interval	kVA	S, D, R1
Maximum fault current contribution	kA rms symmetrical	S, D, R1
Control modes (*voltage*, *power factor*)	text	S, D, R1
Attachments		
Reactive capability curve (indicating effect of temperature and *voltage*)	Graphical Data	S, D, R1
Long-term flicker factor for *generating system*[3]		S, D, R2
Long term flicker factor for *wind farm*[3]		S, D, R2
Harmonics current spectra[3]		S, D, R2

Notes:*

1: A separate data sheet is required for each *generating unit*.

2: Where there is more than one *generating unit*, the identifier should be the same as used on the single line diagram.

3: In accordance with IEC 61400-21.

Wind Turbine/*Wind Farm*		
Item	**Unit**	**Data Category**
Flicker factors in accordance with IEC61400-21	Text / Diagram	S, D, R2
Annual average wind speed	metre/sec	S
Harmonics current spectra	Text / Diagram	S, D, R2
Attachments		
A typical 24 hour power curve measured at 15-minute intervals or better if available		S, D,R2
Startup profile kW, kvar vs time for individual wind turbine		S, D, R2
Startup profile kW, kvar vs time for *wind farm* total		S, D, R2
kW, kvar vs time profiles for individual wind turbine under normal ramp up and ramp down conditions		S, D, R2
High wind shutdown profile kW, kvar vs time for individual wind turbine		S, D, R2
High wind shutdown profile kW, kvar vs time for *wind farm* total		S, D, R2
Low wind shutdown profile kW, kvar vs time for individual wind turbine		S, D, R2
Low wind shutdown profile kW, kvar vs time for *wind farm* total		S, D, R2
Power curve kW vs wind speed		S, D, R2
Spatial arrangement of *wind farm*		S, D, R1

ATTACHMENT 11 TEST SCHEDULE FOR SPECIFIC PERFORMANCE VERIFICATION AND MODEL VALIDATION

A11.1 General

(a) Recorders must be calibrated/checked prior to use.

(b) Recorders must not interact with any equipment control functions.

(c) One chart recorder must be used to provide on site monitoring and rapid evaluation of key quantities during tests even though a digital recorder may be used.

A11.2 Recorder Equipment

Signals shall be digitally recorded and processed and require:

(a) an analogue to digital conversion with at least 12 bit accuracy at full scale;

(b) a sampling rate of at least 3000 samples per second (i.e. 3kHz) for up to 10 seconds unless specified otherwise;

(d) departure from linearity of no more than 0.1% in the slope of normalised output versus input. Normalised means value/full range value; and

(e) DC offset errors not greater than 0.05% of full scale in the analogue circuitry.

A11.3 *Frequency* response

(a) A minimum bandwidth of DC - 10kHz is required (0dB at DC, -3dB at 10kHz). Suitable filtering is required to eliminate aliasing errors.

(b) For relatively slow changing signals (such as main exciter quantities, transducers for MW output etc.) a recording device bandwidth of DC - 100Hz is required.

(c) All test results required in rms values are to be derived at a minimum rate of 100 samples per second.

A11.4 Signal Requirements and Conditioning

(a) Suitable input signal level must be used and allowance must be made for excursions during transients.

(b) Subtraction of an appropriate amount of floating DC from input signals such as stator *voltage* must be provided so that any perturbations are clearly observable on an on-site chart recorder.

(c) Galvanic isolation and filtering of input signals must be provided whenever necessary.

A11.5 Form of Test Results

These must consist of:

(a) a brief log showing when tests were done (time, date, test alphanumeric identification);

(b) chart recordings appropriately annotated;

(c) relevant schematics of equipment and the local transmission system configuration;

(d) lists of data collected manually (e.g. meter readings);

(e) data on Microsoft Excel spreadsheets;

(f) SCADA type printouts showing the User's *power system* configuration at the start of, end of, and any other appropriate time during the test sequence; and

(g) other relevant data logger printouts (from other than the recorder equipment referred to in section A11.2).

A11.6 Test Preparation and Presentation of Test Results

Information/Data Prior to Tests

(a) A detailed schedule of tests agreed by the Network Service Provider. The schedule must list the tests, when each test is to occur and whose responsibility it will be to perform the test.

(b) Schematics of equipment and subnetworks plus descriptive material necessary to draw up/agree upon a schedule of tests.

(c) Most up to date relevant technical data and parameter settings of equipment as specified in Attachment 4 to Attachment 9.

Test Notification

(a) A minimum of 15 business day prior notice of test commencement must be given to the Network Service Provider for the purpose of arranging witnessing of tests.

(b) The *Network Service Provider's representative* must be consulted about proposed test schedules, be kept informed about the current state of the testing program, and give permission to proceed before each test is carried out.

(c) Unless agreed otherwise, tests must be conducted consecutively.

Test Results

(a) Test result data must be presented to the *Network Service Provider* within 10 *business day*s of completion of each test or test series.

(b) Where test results show that *generating unit or generating system* performance does not comply with the requirements of these *Rules* or the *access contract* or *connection agreement* the *Generator* must rectify the problem(s) and the test must, unless otherwise be elected by the *Network Service Provider,* be repeated.

A11.7 Quantities to be Measured

(a) Wherever appropriate and applicable for the tests, the following quantities must be measured on the *generating unit or generating system* under test using either the same recorders or, where different recorders are used, time scales must be synchronised to within 1 msec:

Synchronous generating unit **and** ***excitation control system***

- 3 stator L-N terminal *voltages*
- 3 stator terminal currents
- *Active power* MW
- *Reactive power* MVar
- *Generating unit* rotor field *voltage*
- *Generating unit* rotor field current
- Main exciter field *voltage*
- Main exciter field current
- AVR reference *voltage*
- *Voltage* applied to AVR summing junction (step etc.)
- *Power system* stabiliser output
- DC signal input to AVR

Steam Turbine

- Shaft speed
- *Load* demand signal
- Valve positions for control and interceptor valves
- Turbine control set point

Gas turbine

- Shaft speed (engine)
- Shaft speed of turbine driving the *generating unit*
- Engine speed control output
- Free turbine speed control output
- *Generating unit*-compressor speed control output
- Ambient/turbine air inlet temperature
- Exhaust gas temperature control output
- Exhaust temperature
- Fuel flow
- Turbine control / *load* reference set point

Hydro

- Shaft speed
- Gate position

* Turbine control /*load* reference set point

(b) The *Network Service Provider* must specify test quantities for power equipment other than those listed above, such as those consisting of wind, solar and fuel cell *generating units* which may also involve AC/DC/AC power conversion or DC/AC power *inverters*.

(c) Additional test quantities may be required and advised by the *Network Service Provider* if other special tests are necessary.

(d) Key quantities such as stator terminal *voltages*, currents, *active power* and *reactive power* of other *generating units* on the same site and also *interconnection* lines with the *transmission or distribution system* (from control room readings) before and after each test must also be provided.

SCHEDULE OF TESTS

Table A11.1 - Schedule of tests

	TEST DESCRIPTION		
Test No	**General Description**	***Changes* Applied**	**Test Conditions**
C1	Step change to AVR *voltage* reference with the *generating unit* on open circuit	(a) +2.5 % (b) -2.5 % (c) +5.0 % (d) -5.0 %	• nominal stator terminal volts
C2A	Step change to AVR *voltage* reference with the *generating unit connected* to the system. (with the power system stabiliser out of service) Generating unit output levels: (i) 50% rated MW, and (ii) 100% rated MW	(a) +1.0 % (b) -1.0 % (c) +2.5 % (d) -2.5 % (e) +5.0 % (f) -5.0 % repeat (e) & (f) twice see note (1) below	• nominal stator terminal volts • unity or lagging *power factor* • system base *load* OR typical conditions at the local equipment and typical electrical connection to the *transmission or distribution system* • tests for (i) must precede tests for (ii) • smaller step changes must precede larger step changes
C2B	As for C2A but with the PSS in service	Same as in C2A	Same as in C2A
C3A	Step change to AVR *voltage* reference with the *generating unit connected* to the system. (With PSS out of service) System Conditions : (i) system minimum *load* with no other *generation* on the same bus OR relatively weak connection to the *transmission or distribution system*, and (ii) system maximum *load* and maximum *generation* on same bus OR relatively strong *connection* to the *transmission or distribution system*	(a) +5 % (b) –5 % repeat (a) & (b) twice; see note (5) below	• nominal stator terminal volts • unity or lagging *power factor* • *Generating unit* output at 100% rated MW

	TEST DESCRIPTION		
Test No	**General Description**	***Changes* Applied**	**Test Conditions**
C3B	As for C3A but with the PSS in service	Same as in C3A	As for C3A.
C4	Step change of MVA on the *transmission or distribution system* PSS Status : (i) PSS in service, and (ii) PSS out of service	Switching in and out of *transmission* or *distribution* lines (nominated by the *Network Service Provider*)	• nominal stator terminal volts • unity or lagging *power factor* • system base *load* OR typical conditions at the local equipment and typical electrical connection to the *transmission or distribution system* • *generating unit* output at 50% rated MW
C5	*load* rejection (*active power*)	(a) 25% rated MW (b) 50% rated MW (c) 100% rated MW see notes below	• nominal stator terminal volts • unity *power factor* • smaller amount must precede larger amount of *load* rejection
C6	steady state over-excitation limiter (OEL) operation	Mvar outputs at OEL setting slow raising of excitation to just bring OEL into operation see notes below	• 100% MW output • 75% MW output • 50% MW output • 25% MW output • min. MW output
C7	steady state under-excitation limiter (UEL) operation	Mvar outputs at UEL setting slow lowering of excitation to just bring UEL into operation see notes below	• 100% MW output • 75% MW output • 50% MW output • 25% MW output • min. MW output
C8	Manual variation of *generating unit* open circuit *voltage*	Stator terminal volt (Ut) (a) increase from 0.5 pu to 1.1 pu (b) decrease from 1.1 pu to 0.5 pu see notes below	• in 0.1 pu step for Ut between 0.5-0.9 pu • in 0.05 pu step for Ut between 0.9-1.1 pu

	TEST DESCRIPTION		
Test No	**General Description**	***Changes* Applied**	**Test Conditions**
C9	Mvar capability at full MW output. System maximum *load* and maximum *generation*. Test conducted with as high an ambient temperature as possible.	*Generating unit* MW and Mvar output levels set to 100% of rated values and maintained for one hour.	• System maximum *load* and *generation* • Ambient temperature as high as possible

Notes:

1. For tests C2A and C2B care must be taken not to excite large or prolonged oscillations in MW etc. Therefore, smaller step changes must always precede larger step changes to avoid such oscillations.
2. Figure A11.1 below shows the step changes referred to in the schedule of tests given above. An example is given of a +5% step to the summing junction and then a –5% step. Removal of the +5% ("-5%") step is deemed to be a 5% step.

Fig A11-1 - Application of step signal

Unless specified otherwise the "-5%" step method shown in Figure A11.1 is used.

3. For test C5, the instantaneous overspeed *protection* must be set at an agreed level depending on *generating unit* capability
4. "system" means "*power system*"
5. OR a lower step change, with a larger safety margin, as agreed by the *Network Service Provider*
6. Tests C1,C6, C7 and C8 need not be witnessed by the *Network Service Provider*

SPECIAL SYSTEM TESTS THAT MAY BE REQUESTED

Table A11.2 – Schedule of special system tests

	TEST DESCRIPTION		
Test No	**General Description**	***Changes* Applied**	**Test Conditions**
S1	*Load* rejection (*reactive power*)	(a) -30 % rated MVAR (b) +25 % rated MVAR see notes below	nominal stator terminal volts 0 or minimum MW output
S2	*Load* rejection (*reactive power*)	(a) -30 % rated MVAR see notes below	nominal stator terminal volts Excitation on Manual Control
S3	Step change of MVAR on the *transmission system*	Switching in and out of (a) a *transformer* (b) a *reactor* (c) a capacitor	parallel *transformers* on staggered taps other as determined by the *Network Service Provider*
S4	Islanding of a subsystem consisting of *User's generating units* plus *load* with export of power by means of a link to the *Network Service Provider's* main *transmission system*.	opening of the link	5-10% of *generated* MW exported by means of the link 90-95% of *generated* MW used by the subsystem's *load*
S5	AVR/OEL changeover	*transformer* tap change OR small step to AVR *voltage* reference	initially under AVR control at lagging *power factor* but close to OEL limit
S6	AVR/UEL changeover	*transformer* tap change OR small step to AVR *voltage* reference	initially under AVR control at leading *power factor* but close to UEL limit
S7	Testing of a FACTS device (*SVC*, TCR, *STATCOM*, etc.)	step change to reference value in the summing junction of a control element line switching others as appropriate	MVA initial conditions in lines as determined by the *Network Service Provider*

S8	Tripping of an adjacent *generating unit*	tripping of *generating unit*(s)	initial *generating unit* loading as agreed
S9	Variable *frequency* injection into the AVR summing junction (with PSS out of service)	0.01-100 rad/sec see notes below	as determined by the *Network Service Provider*
S10	Step change to governor/*load* reference	2.5 % step increase in MW demand signal 2.5 % decrease in MW demand signal equivalent of 0.05Hz subtracted from the governor speed ref. equivalent of 0.1 Hz added to governor speed reference see notes below	equipment output at 50-85% of rated MW others as agreed with the *Network Service Provider*
S11	Overspeed capability to stay in the range of 52.0 to 52.5Hz for a minimum of 6 seconds	Digital governor: use software, where practical, to put a step in the speed reference of the turbine governor such that the target speed is 52.0Hz and the overshoot in speed remains above 52Hz and in the range 52-52.5Hz for about 6 sec Use a manual control to raise speed from 50Hz so as to stay in the 52 to 52.5 Hz range for a minimum of 6 sec Where it is practical, use a function *generating unit* to inject an analogue signal in the appropriate summing junction, so that the turbine stays in the 52-52.5 Hz range for a minimum of 6 sec.	Unsynchronised unit at rated speed and no *load*
S12	Underspeed capability	To be proposed by the manufacturer	
S13	Any other test to demonstrate compliance with a declared or registered equipment performance characteristic.	To be advised	

Notes:

1. For tests S1(a) and S2 the var absorption must be limited so that field *voltage* does not go below 50% of its value at rated *voltage* and at no *load* (i.e. rated stator terminal *voltage* with the *generating unit* on open circuit).
2. For test S1(b) the var *load* must not allow stator terminal *voltage* to exceed 8% overvoltage (i.e. 108% of rated value) as a result of the applied change.
3. For test S1 and S2, the instantaneous overvoltage *protection* must be operative and set at an agreed level greater than or equal to 10% overvoltage.

4. For test S2, it may be easier to use AVR control first and then change to manual (provided the change is "bumpless") before the unit trips.
5. For test S9, care has to be taken not to excite electromechanical resonances (e.g. poorly damped MW swings) if the machine is on line.
6. For the test S10 equipment characteristics may require the changes be varied from the nominal values given. Larger changes may be considered in order to more accurately determine equipment performance.

   For test S5 a positive step is applied of X% from the sub-OEL value. But for test S6 a –Y% step from the sub-UEL value as shown in Figure A11.2 is required.

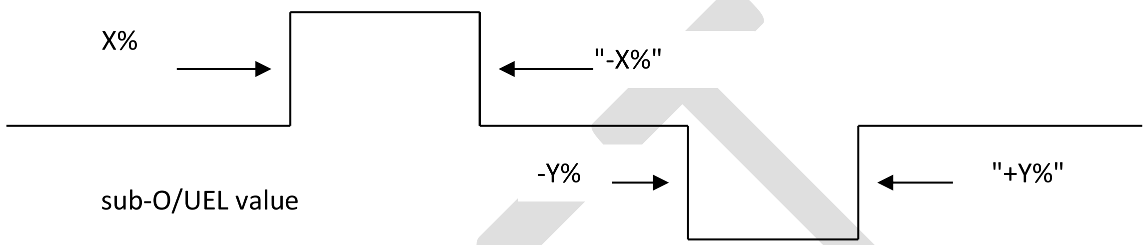

Figure A11-2 - Application of Step Signal

ATTACHMENT 12 TESTING AND COMMISSIONING OF SMALL *POWER STATIONS CONNECTED* TO THE *DISTRIBUTION SYSTEM*

A12.1 Application

This attachment lists the specific requirements for the certification, testing and commissioning of *generating systems,* connecting to the *distribution system* in accordance with clauses 3.6 and 3.7 and for which the provisions of clause 4.2 apply.

A12.2 Certification

The *Generator* must provide certification by a chartered professional engineer with National Engineering Register standing in relevant areas of expertise that the *facilities* comply with the *Rules*, the relevant *connection agreement*, *good electricity industry practice* and relevant standards. The certification must confirm that the following have been verified:

1. The single line diagram submitted to the *Network Services Provider* has been checked and accurately reflects the installed electrical system;
2. All required switches present and operate correctly as per the single line diagram;
3. The specified *generation facility* is the only source of power that can be operated in parallel with the *distribution system*;
4. The earthing systems comply with *Australian Standards* AS/NZS 3000 and AS/NZS 2067 and do not rely upon the *Network Service Provider's* earthing system;
5. Electrical equipment is adequately rated to withstand specified network fault levels;
6. All *protection apparatus* (that serves a network *protection* function, including back-up function) complies with IEC 60255 and has been correctly installed and tested. Interlocking systems specified in the *connection agreement* have been correctly installed and tested;
7. The islanding *protection* operates correctly and disconnects the small *power station* from the network within 2 seconds;
8. Synchronizing and auto-changeover equipment has been correctly installed and tested;
9. The delay in reconnection following restoration of normal *supply* is greater than 1 minute;
10. The *protection* settings specified in the *connection agreement* have been approved by the *Network Service Provider* and are such that satisfactory coordination is achieved with the *Network Service Provider*'s *protection systems*;
11. Provision has been made to minimise the risk of injury to personnel or damage to equipment that may be caused by an out-of-*synchronism* fault;
12. *Control systems* have been implemented to maintain *voltage*, *active power* flow and *reactive power flow* requirements for the *connection point* as specified in the *connection agreement*;
13. Systems or procedures are in place such that the testing, commissioning, operation and maintenance requirements specified in the *Rules,* and the *connection agreement* are adhered to; and
14. Operational settings as specified.

A12.3 Pre-commissioning

Commissioning may occur only after the installation of the metering equipment.

A12.4 Commissioning Procedures

The commissioning of a *generating unit* shall include the checks and tests specified in clauses A12.5 to A12.14.

A.12.5 Operating procedures

- The single line diagram shall be checked to confirm that it accurately reflects the installed plant;
- The documented operating procedures agreed with the *Network Service Provider* and have been implemented as agreed;
- Naming, numbering and labelling of plant agreed with the *Network Service Provider* has been followed; and
- Operating personnel are familiar with the agreed operating procedures and all requirements to preserve the integrity of the *protection* settings and interlocks and the procedures for subsequent changes to settings.

A12.6 Protection systems

- *Protection apparatus* has been manufactured and installed to required standards;
- The settings and functioning of *protection systems* required for the safety and integrity of the *distribution system* operate correctly (at various power levels) and coordinate with the *Network Service Provider*'s *protection systems*. This will include the correct operation of the *protection systems* specified in the *connection agreement* and, in particular:
  - islanding *protection* and coordination with automatic reclosers export/import limiting *protection*;
  - automatic changeover schemes; and
  - fail-safe *generating unit* or *generating system* shutdown for auxiliary *supply* failure or loss of *distribution system supply;* and,
- Any required security measures for *protection* settings are in place.

A12.7 Switchgear installations

- Switchgear, instrument *transformers* and cabling have been manufactured, installed and tested to required standards.

A12.8 *Transformers*

- *Transformer*(s) has been installed and tested to required standards; and
- *Transformer* parameters (nameplate inspection) are as specified and there is correct functioning of on-load tap changing (when supplied).

A12.9 Earthing

- The earthing connections and the design value(s) of earthing electrode impedance are delivered; and
- The earthing systems comply with AS/NZS 3000 and AS/NZS 2067 and do not rely upon the *Network Service Provider*'s earthing system

A12.10 *Generating units*

A12.10.1 Unsynchronised/ disconnected

- *Generating unit* parameters are as specified (nameplate inspection);
- Generating units have been manufactured to meet the requirements of the *Rules* for riding through *power system* disturbances;
- Earthing arrangements of the *generating unit* are as specified;
- Correct functioning of automatic *voltage* regulator for step changes in error signals (when specified);
- Achievement of required automatic *voltage* regulator response time (when specified); and
- Correct functioning of automatic synchronizing equipment prior to *synchronisation*.

A12.10.2 *Voltage* changes

- *Voltage* transients at the *connection point* on connection are within specified limits; and
- Step changes in *voltage* on connection and disconnection (both before and after tap-changing) are within required limits.

A12.10.3 *Synchronous generating units*

- The *generating unit* is capable of specified sustained output of *active power* (when required);
- The *generating unit* is capable of required sustained *generation* and absorption of *reactive power*, (when required);
- Correct operation of over- and under-excitation limiters (when required); and
- Response time in constant *power factor* mode is within limits (when required).

A12.10.4 *Asynchronous generating units*

- Starting inrush current is within specified limits;
- *Power factor* during starting and normal operation is within specified limits; and
- Rating and correct operation of *reactive power* compensation equipment.

A12.10.5 *Inverter connected* (non-AS/NZS 4777.2 certified) *generating units*

- *Power factor* during starting and normal operation is within specified limits; and
- Rating and correct operation of *reactive power* compensation equipment.

A12.10.6 Harmonics and flicker

- Network flicker and harmonics levels before and after connection and confirmation that limits have not been exceeded (not required for directly *connected* rotating machines).

A12.10.7 Additional requirement for *wind farms*

- The level of variation in the output of a wind *generating unit* or *wind farm* is within the limits specified in the *connection agreement*.

A12.11 Interlocks and intertripping

- Correct operation of interlocks, check synchronizing, remote control, permissive interlocking and intertripping.

A12.12 Voice and data communications

- Correct operation of primary and back up voice and data communications systems

A12.13 Signage and labelling

- Signage and labelling comply with that specified in the relevant *connection agreement*.

A12.14 Additional installation specific tests

- The *Network Service Provider* may specify additional installation specific tests and inspections in respect of the physical and functional parameters that are relevant for parallel operation of the small *power station* and coordination with the *distribution and transmission system*.

A12.15 Routine testing

- The *Generator* must test *generating unit protection systems*, including back-up functions, at regular intervals not exceeding 3 years for unmanned sites and 4 years for manned sites and keep records of such tests.

- Where in-built *inverter protection systems* compliant with the AS/NZS 4777.2 requirements are permitted in small power stations with an aggregate rating of more than 30kVA but less than 100kVA, these *protection systems* must be tested for correct functioning at regular intervals not exceeding 5 years. The *User* must arrange for a suitably qualified person to conduct and certify the tests and *supply* the results to the *Network Service Provider*.

A12.16 Non-routine testing

The *Network Service Provider* may inspect and test the small *power station* to re-confirm its correct operation and continued compliance with the *Rules*, *connection agreement*, *good electricity industry practice* and relevant standards. In the event that the *Network Service Provider* considers that the installation poses a threat to safety, to *quality of supply* or to the integrity of the *distribution* and *transmission system* it may *disconnect* the *generating equipment*.

ATTACHMENT 13 GUIDANCE ON ECONOMIC JUSTIFICATION

This Attachment is intended to provide guidance on the economic considerations and justification needed for the investment in *transmission* infrastructure when designed to a higher or lower standard than outlined in the *transmission system planning criteria* in section 2.5 of these *Rules*.

This guidance is not intended to replace or override requirements in the *Access Code* or other higher order regulatory instruments, such as the *Act* or the *WEM Rules*.

When determining the costs and benefits of any proposed deviation from the applicable *transmission system planning criteria*, the *Network Services Provider* should consider, where applicable:

- Calculating the capital, operating and whole-life costs of a design that is compliant with these *Rules* to act as a benchmark for comparison against the alternative design.
- Valuing the potential *reliability* impacts of the alternative design. This is expected to include consideration of effects on:
  - the *Network Service Provider's* performance metrics (for example, system minutes lost, customer interruptions), and
  - other metrics for valuing effects for *Users* (for example, using value of customer reliability).
- Valuing the potential impacts of the alternative design on operational activities and *outage* management plans. Considerations could include, but are not limited to, effects on:
  - incremental network losses.
  - *Essential System Services (ESS)* (for example, where the alternative design affects the market cost of *generation* or *load* rejection).
  - *reactive power* requirements, including *generation* loading, if applicable.
  - the *WEM* including system *constraint* management, and potential re-*dispatch* of *generation* to alleviate system *constraints* if contingencies occur.
  - operational risk mitigation (for example, the use of temporary *generation* to maintain operational capabilities).
  - deliverability of the works program.
- Performing whole-life and net present value costing calculations for the alternative design taking account of:
  - capital and operating costs of the alternative design, or if the alternative design is to defer or negate investment, calculating the expected additional operational costs associated with the existing infrastructure.
  - *power system* operational costs (for example, the effects of network losses, ESS, reactive power requirements, the WEM and operational risk mitigation).
  - costs of any constraint management or re-dispatch of generation.
  - typical annual system loading.

Notes:
Typical annual system loading may be considered using system *load* duration curves to develop equivalent annualised values for the above cost values.

  - sensitivities of the above, where applicable, to evaluate how the identified costs may change through credible ranges of values.
  - cost of undertaking outages between alternative designs.
- Documenting other factors that may be affected by the alternative design, such as:
  - impacts on other *generation* or any connection queue,
  - precedent for future connection designs, and
  - any other benefits the alternative design may provide.

> **Notes:**
> For some of these aspects it may be necessary to evaluate the impacts using a qualitative evaluation scale as calculating quantitative values for direct financial impacts may not be possible.

When determining whether to proceed with any proposed deviation from the applicable *transmission system planning criteria*, the *Network Services Provider* should:

- Undertake a multiple criteria evaluation that considers whether the whole-life cost for the alternative design is comparable to the benchmark compliant design option, or whether it is significantly higher or lower (based on the guidance above).
- If the quantitative analysis indicates there is a significant and identifiable cost saving through the alternative design, then reference should be made to supporting qualitative evaluation to identify if any of these are considered sufficiently critical to outweigh the potential cost savings.
- If the quantitative analysis indicates the alternative design is broadly comparable with the compliant design or the costs are higher, then unless the qualitative evaluation suggests there are significant non-quantified benefits that can be obtained, then the compliant design should be progressed.

RECORD OF AMENDMENTS AND REVISIONS

Request date	**Date Rules effective**	**Clauses(s)**	**Summary of change**
November 2015	1 August 2016	3.2.1 (c) (3) DC injection	Remove clause
		AS 4777:2005 date amendments in various places	Remove AS 4777(2005) date in various places. Update reference to AS/NZS 4777 series as applicable.
		Attachment 1, Glossary	Clarification of definitions: ▪ *Connection point* ▪ Connection assets ▪ *Point of common coupling*
		Various	Typographical corrections
March 2016	1 December 2016	Attachment 1, Glossary 2.3.7.1 (c) *power transfer* conditions	Redefine *credible contingency* events Add new cl. with reporting requirement
		2.5.2.2 (b) N-1 criterion	Clarify *User* agreed access connections
		Attachment 1, Glossary 2.9.4 Maximum fault clearance times	Include a capacity for *Network Service Provider* to accommodate *protection* weak infeed assessments
April 2016	1 December 2016	2.5.4 (b) Normal cyclic rating (NCR) criterion	Amend criterion definition and application
		2.5.8 (c) 2.7 3.4.6 (a)	Electricity (Supply Standards and System Safety) Regulations 2001 replaced by Electricity (Network Safety) Regulations 2015
	1 December 2016 Revision 2	4.2.1 (b) Section 5	Typographical corrections 22 November 2016
	1 December 2016 Revision 3	Figure 3.3, p. 43. 3.6.1 3.5.2(d) Various sections/clauses	Typographical corrections, image, omissions and reformatting 17 January 2017

APPENDIX 2

Technical Rules Review

Submission to the Economic Regulation Authority

Public

1 September 2023

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Glossary

Term	Definition
Access Code	Electricity Networks Access Code 2004 established under the Electricity Industry Act 2004
Act	Electricity Industry Act 2004
AEMO	Australian Energy Market Operator
AQP	Applications and Queuing Policy
AS	Australian Standard
CBEMA	Computer Business Equipment Manufacturers Association
DER	Distributed energy resources
DNO	Distribution Network Operator
EMT	Electromagnetic transient
ERA	Economic Regulation Authority
ER P2/6	Engineering Recommendation P2, revision 6 used in Great Britain
FOS	Frequency Operating Standards
GPS	Generator performance standard
HILP	High Impact Low Probability
HV	High voltage
ITIC	Information Technology Industry Council
kV	Kilovolts
LV	Low voltage
MITS	Main Interconnected Transmission System
MVA	Megavolt ampere
MW	Megawatt
NATA	National Association of Test Laboratories
NCR	Normal Cyclic Rating
NEM	National Electricity Market
NER	National Electricity Rules
NETS	National Electricity Transmission System
NFIT	New facilities investment test
NTC	Network Technical Code
RRST	Rapid response spare transformer
SQSS	Security and Quality of Supply Standards

SWIS	South West Interconnected System
TNO	Transmission Network Operator
UFLS	Under-frequency Load Shedding
WEM	Wholesale Electricity Market
WEM Rules	The Wholesale Electricity Market Rules established under the Electricity Industry (Wholesale Electricity Market) Regulations 2004 (WA)

Executive summary

The Western Australian energy sector has been facing significant change over the last decade, driven by the widespread uptake of customer owned rooftop PV systems, changes in the generation mix towards more renewable generation (displacing fossil fuelled generators), and new technologies such as energy storage solutions.

Whilst a transition to renewables in the generation mix creates more opportunities for low cost and low emissions energy for Western Australians, the sometimes irregular nature of these sources can pose challenges for us at Western Power, in managing our assets and maintaining the reliability and security of the network.

To better plan and manage the changes in the energy sector, and deliver a more affordable, reliable and sustainable energy for our future, in March 2019 the Energy Minister Bill Johnston, announced the State Government's Energy Transformation Strategy. Their vision is, "to provide safe, secure, reliable, low-emission power to Western Australian households and business at the lowest sustainable cost, while allowing new technology to connect and giving people more control over their electricity use,"

To support the State Government's Energy Transformation Strategy, community expectations and changes in the energy market, Western Power are proposing amendments to the Technical Rules.

The Technical Rules are a set of technical requirements for the planning, design, operation and performance of the South West Interconnected System (SWIS). They also provide performance and technical specifications for user equipment connection to the network, facilitating the secure and reliable supply of power for customers in the SWIS.

As per Chapter 12 of the Access Code, Western Power is responsible for the development and application of the Technical Rules, with the Economic Regulation Authority (ERA) playing a key role in approving and publishing the Technical Rules.

Since the Technical Rules commenced on 1 July 2007, except for a mandatory review in 2011 under section 12.56 of the Access Code, changes and updates to the Technical Rules have been infrequent and relatively minor.

A review of the proposed amendments began in January 2020. For the review, Western Power established a working group which included Western Power Engineers, Western Power's consultants (GHD Advisory), the Australian Energy Market Operator (AEMO), Energy Policy WA and the ERA as an observer.

Through the review, Western Power considered more than 100 individual issues that ranged in scope from interpretational issues associated with a single clause to gaps that required the redrafting of significant section of the Technical Rules. All chapters of the Technical Rules and Attachments were considered in the review.

Customer forums were held in June 2021 to create awareness on the proposed changes and drafting and seek feedback to ensure that the proposed changes to user obligations, were fair and reasonable, and fit for purpose. Invitees included residents, land developers, retailers, businesses, local governments, government trading enterprises, electricians, consultants and service providers, large distribution connected generators, select transmission connected generators, AEMO, Energy Policy WA and the ERA.

An initial version of this submission and associated proposed Technical Rule changes were submitted to the ERA on 30 July 2021 and released publicly on the ERA's website on 6 August 2021[1]. After the publication of the request to have the Technical Rules updated, Western Power, the ERA and Energy Policy WA agreed for the request to be withdrawn to enable boarder policy developments to progress. In particular, Energy Policy WA has signalling that, subject to Parliamentary approval, the Technical Rules will become part of the Wholesale Electricity Market Rules (WEM Rules)[2]. The Bill enabling the Technical Rules to be merged with the WEM Rules is expected to pass Parliament later in 2023, after which point drafting on the details of the merged Rules can be progressed.

In anticipation of the boarder changes and recognising that technical issues identified in the 2021 submission remain and, in some cases, have been exacerbated through power system developments in the past two years, Western Power is submitting this updated request for Technical Rule changes. In particular, changes to the transmission planning criteria and to the connection arrangements for small generation on the low voltage distribution system are critical to support the future power system.[3] Resolution of the issues identified will facilitate the process to merge the Technical Rules with the WEM Rules by enabling technical changes to be resolved ahead of the detailed drafting of the merged rules. The Technical Rule change process also requires public consultation with stakeholders.

Most of the issues identified and the changes proposed in this submission are the same as those included in the July 2021 request to the ERA. Updates between the July 2021 and this submission are outlined in section 1.4 of this submission.

This submission and the accompanying proposed Technical Rules drafting represents the culmination of the Technical Rules review process. The changes proposed, if accepted, should ensure customers continue to receive reliable and secure power.

The proposed amendments to the Rules will:

- Align with the requirements of WEM Rules amendments and the government policy decisions by Energy Policy WA.
- Clarify and update the roles and responsibilities for Western Power, AEMO and Users (loads and generators connected to the South West Interconnected Network).
- Provide improved clarity on system performance standards.
- Improve the network investment planning principles and criteria.
- Facilitate easier connection of inverter-based generators, loads and energy storage systems through the introduction of clearer and more suitable performance standards and technical requirements.
- Improve compliance requirements for Users and reduce exemption requirements.
- Improve operational planning and coordination of efforts with AEMO.

Western Power requests the ERA, with the support of the Technical Rules Committee, consider this request to change the Technical Rules.

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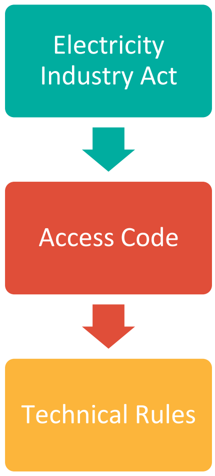
1 Refer to the ERA's website: Proposal to amend Western Power's technical rules - Western Power - 30 July 2021 (TRA.6) - Economic Regulation Authority Western Australia (erawa.com.au)

2 Refer to Energy Policy WA's Information Paper: Energy and Governance Legislation Reforms (Project Eagle), published on 16 January 2023. Available at: https://www.wa.gov.au/government/announcements/energy-and-governance-legislation-reforms-information-paper

3 The future power system is expected to be characterized by much larger sized connections to the transmission system and a larger number and array of technologies being connected to the low voltage distribution system than has historically been enabled by the Technical Rules.

1. Introduction & background



The Technical Rules are a key regulatory and technical document that governs the Western Power network. They stipulate the requirements that facilitate the secure and reliable supply of power for customers in the southwest of Western Australia.

Technical Rules provide the standards, procedures and planning criteria governing the design, construction and operation of a covered electricity network and the standards for the facilities, loads and generators that connect to the network to meet reliability, power quality and safety standards.

The Technical Rules are provided for in Chapter 12 of Electricity Networks Access Code 2004 (the Access Code), which in turn was established in accordance with Part 8 of the *Electricity Industry Act 2004* (the Act).

The objectives of the Technical Rules are outlined in section 12.1 of the Access Code. These are that the Rules:

- are reasonable; and
- do not impose inappropriate barriers to entry to a market; and
- are consistent with good electricity industry practice; and
- are consistent with relevant written laws and statutory instruments.

Section 12.5 of the Access Code also clarifies that where a contract for services provided by means of a covered network is inconsistent with the Technical Rules for that network, then the Technical Rules prevail unless section 12.4A of the Access Code applies[4] or an exemption from the Technical Rules granted under section 12.34 or 12.41 of that Access Code affects that contract.

The Access Code objective is “to promote the economically efficient investment in and operation of and use of, networks and services of networks in order to promote competition in markets upstream and downstream of the networks”.

[4] Section 12.4A relates to the point of interconnection between a non-covered network and a covered network.

1.1 Purpose of the Technical Rules review

Since commencing on 1 July 2007 and, except for a mandatory review under section 12.56 of the Access Code in 2011, the Technical Rules have been subject to infrequent and relatively minor changes. Meanwhile, the characteristics of the SWIS where the Technical Rules apply has been changing. Changes have been driven by:

- Connection of significant amounts of inverter-based generation (wind and solar farms), and
- Increasing levels of distributed energy resources (DER), including rooftop photovoltaic (PV) systems, behind-the-meter storage and electric vehicles.

The changing technical characteristics present challenges that must be met to deliver a secure and reliable supply of electricity to customer. Addressing these challenges requires:

- Effective coordination between Western Power and AEMO,
- Robust network planning criteria,
- Clearly defines roles and responsibilities for Users, Western Power and AEMO,
- Revisions to the User technical requirements and the processes used to assure compliance with those requirements,
- Revision of the Technical Rules to address technology bias and clarify requirements for new technologies including electricity storage facilities.

In response to changes on the way the power system and network is used, broader policy and regulatory reforms have also been or are being progressed. Boarder policy and regularly reforms that changes proposed of the Technical Rules seek to align with include:

- Changing the governance of WEM Rules and Technical Rules
- Introduction of a constrained access market (likely from 2022)
- Re-design of reserve capacity and ancillary service markets
- Changing metering and settlement requirements
- Introduction of a reliability and security framework with Energy Policy WA (State Government) taking the role of coordinator

The purpose of the Technical Rules review is to:

- Respond to the rapidly changing characteristics of the SWIS
- Address legacy issues
- Achieve better alignment with broader policy and regulatory reforms
- Establish a refreshed and robust starting point following regulatory changes that allow anyone to request a rule change

In undertaking the Technical Rules review and developing the changes proposed via this submission, Western Power has considered addressing the matters above and the solutions that align with the Technical Rules objectives as outlined in section 12.1 of the Access Code.

1.2 Review process

Over the past year and a half, Western Power has undertaken a comprehensive review of the Technical Rules. The review considered more than 100 individual issues that ranged in scope from interpretational issues associated with a single clause, to gaps that required the redrafting of significant section of the Technical Rules. All chapters of the Technical Rules and Attachments were considered in the review.

Western Power used a systematic approach to reviewing the Technical Rules. Sections of the Technical Rules that covered similar topics were grouped into a series of work packages. For each work package, potential issues were identified based on:

- Data in Western Power's existing issue register – an internal document where issues with clauses or sections of the Technical Rules are recorded. Issues identified in the register date back to 2007.
- Records of exemptions from the Technical Rules.
- The requirement for updates to align with broader policy and regulatory reforms
- A review of contemporary standards that suggest a potential gap or misalignment in requirements compared with other jurisdictions.
- Input provided by AEMO.

A series of 'issues' and 'solutions' workshops were then conducted to:

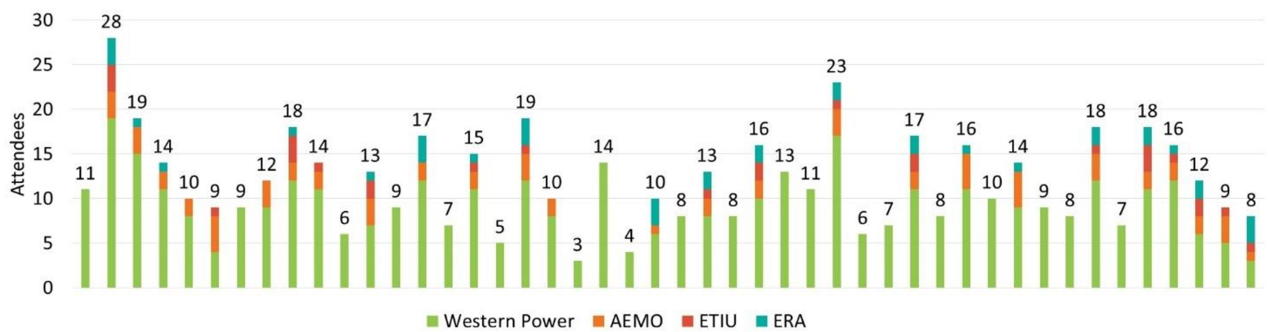
1. Confirm whether identified issues required solving through this Technical Rules review
2. Identified any additional issues that should be addressed through the review.
3. Present and test options addressing the identified issue or issues, including 'no change' options where appropriate.
4. Select the preferred option and clarify the reasons for selection of the preferred option.

Four organisations were invited to participate in the workshops. The organisations and the capacity in which they participated was as follows:

- Western Power (active participant, decision maker)
- AEMO (active participant)
- Energy Policy WA (observer)
- Economic Regulation Authority (the ERA) (observer)

Through the course of the review, 66 people across the four organisations were involved in 46 facilitated workshops and discussions between February 2020 and April 2021 (Figure 1-1).

Figure 1-1: Number of attendees at facilitated discussions



1.3 User consultation

Several of the proposed changes will directly affect Users connected or seeking to connect to Western Power's systems. This includes:

- Re-organisation of Chapter 3 requirements to facilitate navigation.
- Introduction of generator performance standards consistent with the WEM Rules for large generating systems (>5 MVA).
- Updates to the generator performance standards for small generating systems (≤5 MVA)
- Remove technology gaps (inverter connected generator, energy storage systems) and ambiguity for loads.
- Clarification on technical requirements that reduce the need for exemptions (e.g., main switch requirements, compliance and monitoring obligations).
- Alignment of requirements for remote monitoring with other jurisdictions and with revised technical requirements for voltage and reactive power control.
- Adoption of updated Australian Standard requirements for inverter connected small generating systems.
- Simplify protection requirements, including grouping these requirements into a single section.

Western Power held two User forums in June 2021 and invited submissions for a two week period following the forums.[5]

- 69 participants attended the user forum focused on large generating systems on 9 June 2021.
- 71 participants attended the user forum focused on small generating systems on 10 June 2021.

No requests for modifications or changes in the approach were received in response to Western Power's invitation. As such, changes reflected in this submission reflect those changes outline in the User forums.

1.4 Changes from the July 2021 request to this July 2023 request

The issues and proposed drafting changes in this July 2023 request are the same as those requested in July 2021 except for the following:

- Alignment with the requirements of the WEM Rules in the July 2021 request referenced the official version of the WEM Rules dated 1 July 2021, whereas this request aligns with the companion version of the WEM Rules dated 22 July 2023. This version includes some amendments yet to take affect but that are expected to be in place by the time the final updated to these Technical Rules are approved.
- The proposed change to address a gap in system strength requirements has been updated to align with expected WEM Rule changes that require Western Power as the Network Operator to trigger procurement processes for non-co-optimised essential system services to address system strength issues. Refer to section 3.14 of this submission.
- Changes to the Electricity Act 1945 are no longer anticipated to be sufficiently resolved to enable a boarder frequency band to be used for smaller systems and for low voltage systems to move away from 230 V to the levels consistent with the nationally accepted 240 V. Consequently:

[5] Both forums covered general changes for Users and the requirements for loads.

- – No changes are proposed to introduce provisions for stand-alone power system or disconnected microgrids. Chapter 8 of the July 2021 submission has been deleted.
  – Changes to the distribution voltage limits used in the low voltage distribution system have reverted to the provisions in the current Technical Rules (i.e., structural changes proposed in July 2021 are retained but technical requirement changes are no longer being proposed). Refer to section 3.5 of this submission.
- Additional justification for the transmission planning criteria is provided, which includes mapping of the current criteria to the proposed requirements captured in demand groups. The final subsection of section 4.1.3 of this submission is new.
- The proposed drafting for the transmission planning criteria has been updated to:
  – Remove the requirement for the Network Service Provider to develop and then jointly agree with AEMO a 'Generation Dispatch for Network Planning Guideline' describing the process used when setting the generation dispatch used in planning timescales.
  – Introduce a requirement for the Network Service Provider to develop and review at least every three year a guideline (the Transmission Planning Guideline) that set outs how the Network Service Provider apples the requirements in the new criteria, including the background conditions for the functional areas of the transmission system (i.e. .e., the generation connections, the demand connections, the sub transmission system, and the Main Interconnected Transmission system (or MITS));
  – Remove Attachments 13 and 14. Both Attachment 13 (background conditions used in planning of the MITS) and Attachment 14, which provided examples showing the application of the transmission planning criteria, now appear in the Transmission Planning Guideline.
- Requirements for loads with embedded generation that participate in load shedding has been clarified (including that the provisions are applicable to embedded electricity storage). Refer to section 6.7.2 of this submission.
- Existing obligations that allow the Network Service Provider to re-confirm compliance of small generators with the Technical Rules have been made clearer and have been expanded to allow greater flexibility and align with appropriate requirements as the number of small generators increases. Refer to sections 6.4.5, 6.5.4 and 6.6 of this submission.
- For small generators connected to the low voltage distribution system, proposed Technical Rule drafting and explanation of the issues and proposed changes has been updated Refer to sections 6.5 and 6.6 of this submission. The updates enable pro-active solution to emerging issues at the low voltage network that are being driven by the rapid uptake of a range of small generator technologies (e.g., rooftop PV systems, batteries, electrical vehicles). The new changes also provide for more consistency across the two sections of the proposed Technical Rules that apply to these small generators (via standard connection arrangements and via other connection arrangements).
- Proposed drafting in chapter 5 that outlines the operational criteria for the transmission system has been updated. Busbar faults are not currently considered in the contingency criteria used in operations and so the previous proposed requirement to consider these in clause 5.4.1 of the proposed Technical Rules has been removed for the July 2023 version.
- Editorial changes to clarify wording, fix unintended errors and update Glossary terms, including to better acknowledge overlaps with the WEM Rules.

1.5 Outcomes of the review

This submission represents the culmination of the Technical Rules review process. The changes proposed, if accepted, should ensure customers continue to receive reliable and secure power. Changes when made will also:

- Enable higher levels of decarbonisation on the SWIS through enhanced performance standards.
- Provide for efficient network development guided by enhanced planning criteria.
- Deliver additional grid robustness and resilience by facilitating energy storage technologies.
- Allow for more efficient grid connection process with fewer exemptions required.

Many of the changes will clarify, simplify and improve the way Western Power manages and invests in the SWIS. Advantages for Western Power (many of which flow on to Users) include:

- Providing clear investment signals for Western Power as the improved transmission and distribution system planning criteria will be more flexibly respond to changes in demand, more fully incorporate risk-based planning methods, and provide for clearer outage restoration times.
- Providing clear technical requirements electricity storage systems connections (such as batteries), thus provide clarity for Western Power investments and customer connections.
- Improving internal and external processes with greater alignment with WEM Rules and Access Code.
- Improving the customer experience through the new and improved classifications for inverter-based distribution generator connections.
- Improving the visibility, reliability and security of the system through the revised generator performance standards for greater than 5 MVA generators. The changes will also improve customer experience.
- Improving the monitoring and reporting of compliance to the Rules thus improving network safety, reliability and security.
- Enhancing the working relationship with AEMO, as the review will resolve several roles and responsibility overlaps with AEMO including – planning, system restart, underfrequency load shedding, voltage management and outage planning.

1.6 Transition to updated Technical Rules

Changes to the Technical Rules come into effect on the date the changes are approved by the Economic Regulation Authority.

All customer connection applications and Western Power projects initiated post the approval date must adhere to the new Rules.

Customer connection applications and Western Power projects that commenced prior to the approval of the Technical Rules will be assessed on a case by case basis. In determining whether the new requirements should be met for these in-progress applications and projects, Western Power will consider the degree of maturity of the project and readiness for the proposed change when determining whether the revised Technical Rules should apply. Western Power will employ fair judgement and will be reasonable in its determinations.

Western Power notes that proposed changes to grandfathering and ongoing suitability clauses (discussed in section 2.6 of this submission) provide a framework that recognise prior version of the Technical Rules should continue to apply and introduces a mechanism for revised Technical Rule provisions to be complied with following modifications or for power system performance requirements.

1.7 Terminology used in this report

All references to the Technical Rules are references to the current version of the Technical Rules unless otherwise specified. This convention has been adopted as the clause numbering the updated Technical Rules is subject to change. The current version of the Technical Rules is version 3 from 2016. Previous versions referred to in this submission include version 1 from 2016 and version 2 from 2016.

Where revised clause numbers are referenced, the convention 'proposed Technical Rules' is used.

References to large and small generators and generating systems in this report use the proposed new Glossary definitions for large and small generating systems:

- references to large generators in this report mean generating systems with a total rated capacity exceeding 5 MVA, and
- references to small generators mean generating systems with a total rated capacity equal to or less than 5 MVA

These conventions are consistent with proposed changes outlined in section 3 of this submission.

1.8 Structure of this document

The remaining structure of this document is summarised in Table 1-1.

Table 1-1: Structure of this submission

Section of this submission	Coverage
Section 2	Changes proposed to chapter 1. This chapter covers general requirements.
Section 3	Changes proposed to sections 2.1 to 2.4. These sections outline the transmission and distribution system performance requirements.
Section 4	Changes proposed to sections 2.5 to 2.8. These sections outline the transmission and distribution system planning requirements.
Section 5	Changes proposed to section 2.9 of the Technical Rules. This section outlines the transmission and distribution system protection requirements.
Section 6	Changes proposed to Chapter 3 of the Technical Rules. This chapter covers User requirements.
Section 7	Changes proposed to Chapter 4 of the Technical Rules. This chapter covers inspection, testing, commission and decommissioning requirements.
Section 8	Changes proposed to Chapter 5 of the Technical Rules. This chapter covers the transmission and distribution system operation and coordination requirements.
Section 9	Changes to Attachments to the Technical Rules, and changes spanning multiple chapters.

2. General requirements

General requirements are set out in Chapter 1 of the Technical Rules. This includes general provisions on the authorisation, application, commencement and interpretation of the Technical Rules. Sections 1.6 to 1.8 cover requirements to act reasonably and mechanisms for dispute resolution, as well as general User obligations and Network Service Provider obligations. Finally, section 1.9 covers variations and exemptions from the Technical Rules.

Chapter 1 also covers exemptions and variations from the Technical Rules as well as ongoing suitability requirements.

The structure of these sections of the Technical Rules is illustrated in the following diagram.

1.1 – Introduction
1.2 – Authorisation
1.3 – Application
1.4 – Commencement
1.5 – Interpretation
1.6 – The network service provider and users to act reasonably
1.7 – Dispute resolution
1.8 – Obligations
1.9 – Variations and exemptions from the rules

1.6 – The network service provider and users to act reasonably
- 1.6.1 Importance of objectives
- 1.6.2 Acting reasonably

1.8 – Obligations
- 1.8.1 General
- 1.8.2 Obligations of the Network Service Provider

1.9 – Variations and exemptions from the rules
- 1.9.1 User Exemptions from these Rules
- 1.9.2 Network Service Provider Exemptions from these Rules
- 1.9.3 Amendment to the Rules
- 1.9.4 Transmission and Distribution Systems and Facilities Existing at 1 July 2007
- 1.9.5 Ongoing Suitability

The limitations, issues and proposed solution to address issues that have been identified through the Technical Rules review process are discussed in the sub-sections that follow.

2.1 Authorisation

Clause 1.2 sets out authorisations of the Technical Rules and aligns with Chapter 12 of the Access Code. This clause provides a list to guide readers regarding the matters addresses by the Technical Rules.

2.1.1 Current issue

Changes proposed in this request need to be reflected in an updated list of authorisations. The following issues with the current list were identified:

- Lack of alignment with recent updates to Chapter 12 and Appendix 6 of the Access Code.
- Better linkage between Technical Rules and WEM Rules is required. Some authorizations are required to clarify requirements for coordination between Western Power as the Network Service Provider and AEMO.
- As discussed in section 9.4 of this submission, references to System Management need to be updated to reflect transfer of relevant functions to AEMO.

2.1.2 Solution options & preferred solution

Western Power considered options to address the above concerns, which included:

a) Updates to address the issues identified above.

b) No change.

Western Power proposes changes consistent with option a). The proposed changes clarify the authorisations of the Technical Rules, align with updates to the Access Code and clarify coordination between AEMO and Western Power. Minor wording amendments also improve clarity.

2.2 Application of the Technical Rules

Section 1.3 of the Technical Rules sets out the application of the Technical Rules. Under current drafting, the Rules apply to the Network Service Provider in its role as the owner and operator of the transmission and distribution system, System Management in its role as operator of the power system, and Users of the transmission or distribution system.

2.2.1 Current issue

The application of the Technical Rules needs to be updated to reflect the movement of the System Management role to AEMO.

2.2.2 Solution options & preferred solution

Western Power considered the following options for addressing the above concerns:

a) Define the role for AEMO clause 1.3(b)(2) of the Technical Rules and cross-reference to clause 2.1A in the WEM Rules, which outlines AEMO obligations.

b) No change.

Western Power has proposed changes that align with option a). The changes proposed to reflect the role of System Management moving to AEMO align with other changes proposed in section 9.4 of this rule change request and align with changes made in higher-order legislation and regulations such as the *Electricity Industry Act* and the WEM Rules.

The retention of the reference to AEMO in this clause does not place any obligations on AEMO. Rather, it clarifies for all users that AEMO has a role within the Technical Rules context. AEMO's role is set out in specific clauses. AEMO does not have any direct obligation under the Technical Rules. However, several clauses require either the Network Service Provider or other Users to advise AEMO of changes.

2.3 Network service provider obligations

The general obligations for the Network Service Provider that are covered by the Technical Rules are set out in section 1.8.2. This section sets out general obligations with more detailed obligations related to specific topics provided in relevant chapters of the Technical Rules.

2.3.1 Current issue

Changes proposed in this request need to be reflected in an updated list of obligations for the network service provided. Specifically, updates are required to cover the following gaps where associated changes are made:

- Providing for the review and assessment of generator performance standards.
- Providing a requirement to maintain a register of performance requirements for User facilities.

A gap in the coverage for recovery or contingency plans also exists in clause 1.8.2 of the Technical Rules. Inclusion of a requirement in this clause would make current practice more transparent and ensure these plans are kept up to date.

2.3.2 Solution options & preferred solution

Western Power considered options to address the above concerns, and the proposed solution addresses each of the issues. The proposed solution is consistent with other changes proposed, removes potentially confusing terminology and improves the transparency of practice.

2.4 Variations and exemptions

Sections 1.9.1 and 1.9.2 cover variations and exemptions from the Technical Rules. There are two broad types of exemptions from the Rules:

- Clause 1.9.1 covers User Exemptions from the Rules and provides that a user, applicant or controller may apply to Western Power for an exemption from one or more requirements of its Technical Rules.
- Clause 1.9.2 covers Network Service Provider Exemptions from the Rules. It allows the Network Service Provider to apply to the ERA for an exemption from one or more requirements of the Technical Rules for itself and all applicants, users and controllers of its network.

Collectively, the purpose of these clauses is to provide for compliance with the Technical Rules where it's not economical or technically feasible to meet the requirements of the rest of the Technical Rules.

2.4.1 Current issue

Several potential points of clarity were raised through the course of the Technical Rules review. These included:

- Whether an exemption is needed under the Technical Rules if a generator agrees to a negotiated generator performance standard under the Technical Rules that falls between the minimum and ideal requirements?
- Whether an exemption was needed under the Technical Rules if generators agree on generator performance standards under the WEM Rules?
- Identification of a gap whereby the ERA maintains a list of exemptions and variations granted under the Access Code and in accordance with clause 1.9 of the Technical Rules. However, not provision is made for the Network Service Provider to maintain similar records.

2.4.2 Solution options & preferred solution

Western Power considered several changes to address these issues. The preferred solution incorporates:

- Drafting notes that clarify no exemption is required for a generator performance standard negotiated and agreed under the Technical Rules where the agreed outcome for each standard is within the minimum and ideal generator performance standard.
- A clause explicitly stating that no exemption is needed for a generator that negotiates and agrees on generator performance standards under the WEM Rules.
- A new clause requiring the Network Service Provider to record exemptions or variations in its own right.

The proposed changes make the variation and exemption provisions clearer and will facilitate better tracking of these arrangements by the Network Service Provider going forward. Further, Western Power already records exemptions and variations so the change does not alter existing practice.

2.5 Amendment to the Technical Rules

Section 1.9.3 of the Technical Rules provides clauses relating to amendment of the Technical Rules by two mechanisms:

- Clause 1.9.3(a) relates to rule changes made under the Access Code that will now be subject to the new Technical Rule change process.
- Clause 1.9.3(b) provides a mechanism for User's to prompt changes to the Technical Rules. It allows Users to seek a change via the Network Service Provider where the Technical Rules uses an equal or less onerous standard than provided for in international or Australian Standard. Clause 1.9.3(b) also requires submissions be supported by a report from a competent body, approved by the Australian National Association of Test Laboratories (NATA), which confirms that the requirements of the proposed International or Australian Standards are equal or more onerous to those of the specified Standard.

2.5.1 Current issue

The Technical Rules change management process has been modified so that any person can submit a proposal to amend the Technical Rules. Previously, clause 1.9.3(b) was the only mechanism through which Users could seek changes to the Technical Rules because the Network Service Provider was the only entity able to submit rule changes to the ERA.

The requirement to support a submission to the Network Services Provider under clause 1.9.3(b) with a report from a competent body, approved by the Australian National Association of Test Laboratories (NATA), is not workable. NATA as labs can only issue reports which they are accredited to provide. To provide a report in the format required for the clause would contravene the NATA rules and regulations for laboratory accreditation and therefore has never been used.

2.5.2 Solution options & preferred solution

Western Power considered the following options to address the above issues:

a) Updating clause 1.9.3 to refer to the new Technical Rule change process outlined in the Access Code.

b) Deleting clause 1.9.3(b) on the basis that all Users can submit requests for changes to the Technical Rules to the Technical Rule Committee.

c) Delete the requirement to provide a NATA approved report in clause 1.9.3(b).

d) No change.

Western Power has proposed changes consistent with option b). All Users can now submit a request for changes to the Technical Rules, including for the types of changes contemplated in clause 1.9.3(b); as such, the clause is no longer needed.

Further, Users who would like to use an alternative international or Australian Standard from those specified in the Technical Rules can apply for an exemption under clause 1.9.1. Western Power notes, in the past, where customers were unable to comply with a technical requirement (e.g., deviation from AS 4777) but believed that another standard was appropriate, they have applied for an exemption with a supporting NATA report and in the past Western Power has accepted this.

The references to clauses in the Access Code remain correct following the changed Technical Rule change process; as such, no change to clause 1.9.3(a) is required.

2.6 Grandfathering and ongoing suitability

Section 1.9.4 of the Technical Rules relates to transmission and distribution systems and User facilities existing on 1 July 2007 and is intended to avoid non-compliance issues that would otherwise arise for the equipment installed before commencement of the Rules that may otherwise apply. The current drafting provides a mechanism through clause 1.9.4(b) for this equipment to be brought up to compliance with any updated Technical Rule requirements when it is upgraded or modified.

Section 1.9.5 covers the ongoing suitability of equipment deemed by section 1.9.4 to comply with the Technical Rules. It places an obligation on Users and the Network Service Provider to ensure the equipment covered by section 1.9.4 are monitored and continue to meet safety and suitability requirements as the conditions of the power system change.

2.6.1 Current issue

Issues identified with section 1.9.4 of the Technical Rules include:

- Gap for equipment that is installed after 1 July 2007, such that there are no clear grandfathering provisions as the Technical Rules continue to change.
- Lack of clarity on the application of the provisions to the replacement of individual components or assets within a sub-system.
  - For example, where protection relays are replaced, but the overall sub-system performance is limited due to other components, it is unclear if further upgrades to the system or sub-system are required to meet revised Technical Rule requirements (as applicable).
  - No consideration to the materiality of the change is given. Following on from the previous point, where part of the system is replaced but the technical limitations persist due to other components, there is no guidance on if the materially of the change should be considered to make further upgrades to meet Technical Rule requirements.
- The terms “modified” and “upgraded” are not defined in the Glossary.
- The current wording of 1.9.4 implies an exemption to all of the Technical Rules, which is not appropriate. For example, current procedural rules should be applied for all Users, and not just Users connected post 1 July 2007.

Issues identified with section 1.9.5 of the Technical Rules include:

- There is no mechanism for the Network Service Provider to require a User to:
  - Demonstrate compliance or that their equipment is being monitored on an ongoing basis
  - Upgrade or modify their equipment to ensure power system performance standards can continue to be met.
- Clause 1.9.4 does not acknowledge clause 1.9.5, which creates a window for the User facilities to be deemed to comply with the monitoring requirements in clause 1.9.5.

2.6.2 Solution options & preferred solution

The purpose of grandfathering clauses is to recognise historical compliance. These provisions avoid the cost of unnecessary upgrades to equipment following a change to the Technical Rules. However, grandfathering is not intended to avoid upgrades when it comes time to replace the equipment. Nor is it intended to create operability issues, power system safety and security concerns by allowing unsuitable facilities to remain connected.

Ongoing suitability clauses work together with grandfathering clauses to ensure the power system needs are not deprioritised over the desire to avoid the cost of necessary upgrades to outdated facilities while at the same time avoiding the cost of unnecessary upgrades.

Western Power considered options that strike a balance between recognising ongoing historical compliance and providing a mechanism to require necessary upgrades to outdated technology. The preferred solution features:

- Broadening section 1.9.4 so that it covers and provides for appropriate grandfathering arrangements for all facilities and equipment covered by the Technical Rules (not just facilities and equipment connected at 1 July 2007). The additional sub-clause covering facilities installed after 1 July 2007 clarifies the version of the Technical Rules that applies is that in force at the time the facility or equipment was commissioned, or a connection agreement was reached (as applicable).
- Modify the existing clause that requires upgraded or modified equipment installed at 1 July 2007 to comply with the updated version of the Technical Rules so that it applies to all equipment covered by the Rules.
- Introduce a requirement for the Network Service Provider to develop, maintain and publish guidelines to inform Users and provide examples of upgrades and modifications covered by clause 1.9.4. The purpose of this guideline is to provide guidance where the terms 'upgraded' or 'modified' could be ambiguous. This clause also addresses 'relevant generator modifications', a term introduced in changes proposed to Chapter 3 of the Technical Rules (see section 6.3.3), which is analogous to the same term used in the WEM Rules.
- Introduce provisions that allow the Network Service Provider to require Users to:
  - demonstrate their equipment is being monitored in accordance with clause 1.9.5(a) and
  - upgrade or modify their equipment to ensure power system performance can continue to be met.

  User's equipment can significantly affect the ability for power system performance requirements to be met. Western Power considers there are circumstances where the most efficient way to meet power system performance requirements is for Users to upgrade their legacy facilities. On this basis, it is prudent to have a mechanism allowing the Network Service Provider to require a User to upgrade legacy facilities and for the Network Service Provider to have a requirement to give a clear rationale for any such requirement.

3. Transmission and distribution system performance

The system performance standards for the transmission and distribution systems are defined in section 2.2 of the Technical Rules, and obligations are placed on Western Power as the Network Service Provider to meet those performance standards in section 2.3. Section 2.4 of the Technical Rules describes functional requirements for the automatic under-frequency load shedding (UFLS) scheme relied upon to control frequency following multiple contingency events.

For the SWIS, system performance standards are also provided for in the WEM Rules. The standards outlined the Technical Rules and associated Network Service Provider obligations should align with and not replicate the obligations in the WEM Rules.

The current structure of sections 2.1 to 2.4 of the Technical Rules is illustrated in the following diagram.

2.1 – Introduction
2.2 – Power system performance standards
2.3 – Obligations of Network Service Provider in relation to power system performance
2.4 – Load shedding facilities

2.2 Power system performance standards

- Frequency variations (2.2.1)
- Power quality (2.2.2 – steady state voltage, 2.2.3 – flicker, 2.2.4 – harmonics, 2.2.5 – negative phase sequence voltage, 2.2.6 electromagnetic interference)
- Stability (2.2.7 transient rotor angle, 2.2.8 oscillatory rotor angle, 2.2.9 short term voltage, 2.2.10 temporary over-voltages, 2.2.11 long-term voltage)

2.3 Obligations of Network Service Provider in relation to power system performance

- Frequency control (2.3.1)
- Load to be available for disconnection (2.3.2)
- Power Quality (2.3.3 – flicker, 2.3.4 – harmonics, 2.3.5 - negative phase sequence voltage, 2.3.6 - electromagnetic interference)
- Power system stability and dynamic performance (2.3.7.1 – short term stability, 2.3.7.2 – short term voltage stability, 2.3.7.3 – long-term voltage stability, 2.3.7.4 – validation of modelling)
- Transfer limits and performance assessment (2.3.8 – limit determination, 2.3.9 – assessment of performance)

2.4 Load shedding facilities

- Settings of Under-frequency load shedding schemes (2.4.1)

The limitations, issues and proposed solutions to address problems that have been identified through the Technical Rules review process are discussed in the sections that follow.

3.1 Structural revision of sections 2.1 to 2.4 of the Technical Rules

The proposed solutions to the issues identified through the Technical Rules maintain a similar high-level structure to these sections of the Technical Rules. However, they do necessitate some revision and rearrangement of the clauses within sections 2.1, 2.2, 2.3 and 2.4.

The revised structure is illustrated in the following diagram. The reasons for the changes are explained in the subsections that follow.

2.1 – Introduction
2.2 – Power system performance standards
2.3 – Obligations of Network Service Provider in relation to power system performance
2.4 – Load shedding facilities

2.2 Power system performance standards

- Frequency variations (2.2.1)
- Transmission voltage (2.2.2.1 – performance timeframes, 2.2.2.2 performance criteria, 2.2.2.4 - pre-event limits, 2.2.2.4 – step change limits, 2.2.2.5 - post-event limits, 2.2.2.6 – transient overvoltage, 2.2.2.7 temporary undervoltage
- distribution voltage (2.2.3.1 – steady state limits, 2.2.3.2 step change limits, 2.2.3.3 – transient overvoltage)
- Power quality (2.2.4 – flicker, 2.2.5 – harmonics, 2.2.6 – negative phase sequence voltage, 2.2.7 Electromagnetic interference)
- Stability (2.2.8 transient stability, 2.2.9 oscillatory stability, 2.2.10 voltage stability)

2.3 Obligations of Network Service Provider in relation to power system performance

- Power quality (2.3.1 – flicker, 2.3.2 – harmonics, 2.3.3 - negative phase sequence voltage, 2.3.4 – electromagnetic interference)
- Power system stability and dynamic performance (2.3.5.1 – stability and modelling guidelines, 2.3.5.2 – stability and modelling obligations, 2.3.5.3 – validation of modelling results)
- Transfer limits and performance assessment (2.3.6 – limit determination, 2.3.7 – assessment of performance)
- 2.3.8 System restart capability
- 2.3.9 System strength

2.4 Load shedding facilities

3.2 Purpose and applicability of the system performance standards

The introduction of chapter 2 of the Technical Rules (clause 2.1) describes the coverage of the section:

> *This section 2 describes the technical performance requirements of the power system, and the obligations of the Network Service Provider to provide the transmission and distribution systems that will allow these performance requirements to be achieved. In addition, it sets out criteria for the planning, design and construction of the transmission and distribution systems.*

Western Power has identified several issues with the purpose and applicability of the sections describing the power system performance standards. Specifically:

- The applicability of the system standards in operating and planning timeframes is not always adequately distinguished.
- It is currently unclear whether Users should expect the system performance standards to be continually achieved or under what conditions system performance may fall outside the limits specified in the standards.

- The option for Users connecting to the network to negotiate alternative system standards that might logically appear in this section of the Technical Rules does not appear.

These issues are addressed in turn in subsequent sections.

3.2.1 Applicability of systems standards in operational and planning environments

The applicability of power system performance standards is missing from the Technical Rules. As such, it is not possible to understand whether the standards are intended to be those Western Power seeks to achieve when planning the network or if they are the standards that should be delivered when operating the network.

The system standards used when planning a network may be different from the system standards that can be reasonably expected when operating the system. In some instances, the standards used to plan the network are tighter than those that apply in operational timeframes. This approach recognises that in planning timeframes it is not possible to anticipate the range of circumstances that may occur operationally. If more arduous conditions occur during operational timeframes than considered during planning timeframes it may not be possible to stay within the more stringent planning standards.

While the current version of the Technical Rules does not set out different system performance standards for operational and planning timeframes, Western Power typically applies margins when planning the power system to provide confidence that the specified system performance standards will be achieved during operational timeframes.

The provisions in chapter 2 of the Technical Rules should specify limits that are consistent with current practices. Clarifying the purpose of chapter 2 via amendments to clause 2.1 would help readers of the Technical Rules (including Users, AEMO, Western Power and the ERA) interpret subsequent clauses consistently.

In developing the options to address the lack of clear purpose for chapter 2, Western Power considered the following options:

a) The standards are those that Western Power seeks to achieve when planning the network.

b) The standards are those that Western Power seeks to achieve when planning and operating the network.

In selecting the preferred approach, Western Power considered approaches taken in other jurisdictions. For example, in the UK, the equivalent technical codes are prescriptive about planning and operational performance standards and treat these separate. The Grid Code that applies to the National Grid Electricity Transmission outlines the performance standards in the Planning Code, for example, in PC.4 (Planning Procedures) and PC.6 (Planning Standards), and the operational performance standards are outlined in the Operating Codes.

In the NEM, the NER provides both operational and planning standards together (i.e., there is no distinction). However, network planning standards are further articulated through licence conditions.

Western Power recommends option b) that the standards are those that Western Power seeks to achieve when planning and operating the network. A new paragraph has been added to clause 2.1 to enact this change. In addition, where appropriate, changes have been recommended to other clauses to:

- Differentiate between planning and operational limits, and
- More clearly define the boundary between distribution and transmission system standards.

3.2.2 Applicability of system standards to User connections

In the NEM, clause S5.1a.1 of the NER indicates to registered participants (i.e., parties connecting to the system) how the system standards set out in that section of the NER should be interpreted. That clause specifically clarifies that system standards may not be fully complied with at the connection point under all circumstances.[6]

The drafting of the NER arguably helps manage the expectations of connected and connecting parties regarding power system performance. It facilitates subsequent negotiations around the system standards at the connection point between the Network Service Provider and the connecting party.

In contrast, the Technical Rules are silent on how the system standards should be interpreted as applying across the network.

In reviewing the system standards in the Technical Rules, Western Power considered whether a similar clause to that which applies in the NEM should be adopted in the revised Technical Rules and under what conditions the system standards should be met.

On the basis that it would provide greater clarity for network users regarding the performance they should expect at the connection point, Western Power proposes revising section 2.1 of the Technical Rules to include an explicit statement that the network user should not rely on the system standards being achieved under all circumstances.

While the NER remains silent on the circumstances under which registered participants should not expect to rely on the system standards being fully complied with at a connection point, the clause S5.1a.1 of the NER does provide that:

> *"…a Registered Participant should expect to be reasonably informed of circumstances where the standard of supply at its connection points will not conform to the system standards."*[7]

Typically, Network Service Providers and AEMO discharge this responsibility through the connection agreement process.

Western Power has considered how network users may be afforded similar conditions under the Technical Rules. Network users are more likely to experience a standard of supply that does not conform to the system standards (as proposed in this Rule Change request) during system restarts and following contingency events. Therefore, the revisions proposed to clause 2.1 include the following statement:

> *A User should not rely on power system performance standards being fully complied with at a connection point under all circumstances. During the process of restoring the power system from a system shutdown or major supply disruption, the power system may not meet the power system performance standards defined in section 2.2.*

3.2.3 Negotiating alternative system standards

In other jurisdictions, there are provisions that allow connecting parties to negotiate standards at their connection point that differ from the system standards. For example, in the NEM clause S5.1a.1 of the NER states:

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6 S5.1a.1 of the NER states: "A *Registered Participant* should not, by virtue of this schedule, rely on *system standards* being fully complied with at a *connection point* under all circumstances. However, a Registered Participant should expect to be reasonably informed of circumstances where the standard of *supply* at its *connection points* will not conform to the *system standards*."

7 S5.1a.1 of the NER.

Except for standards of frequency and system stability, a Registered Participant should have the opportunity to negotiate or renegotiate relevant terms of a connection agreement (including relevant charges), to improve the standard of supply to the level of the system standard.

In the NEM, the negotiation of standards is typically done through the connection process.

While the technical requirements of User facilities are covered in chapter 3 of the Technical Rules, chapter 3 technical requirements aim to achieve the system standards set out in chapter 2. There is currently no explicit process included in the Technical Rules that allow a User to seek to negotiate a variation to the system standards at their connection point that differs from the system standards specified in chapter 2 of the Technical Rules. However, there is an exemption process defined in chapter 1 of the Technical Rules that could be used for this purpose.

Western Power considered the following options to clarify the potential to vary the system standards applicable to a particular User's connection:

a) Introducing a new sub-clause in clause 2.1 of the Technical Rules to allow users to negotiate a higher or lower standard provided this would not impact other network users. The cost associated with delivering a higher standard at the connection point should be borne by the User seeking the higher performance standard.

b) Reviewing the exemption provisions in clause 1.9.2 of the Technical Rules to confirm that the provisions provide an appropriate means of negotiating standards that differ from the system standards specified in chapter 2.

Option b) was identified as the preferred approach. A review of the exemption process did not identify any change was required to allow the existing exemption process to the utilised if needed to vary the system standard experienced by a User.

3.3 Frequency operating standards

The system performance frequency operating standards (FOS) are intended to describe the range within which Users can expect the frequency of the power system to remain. The FOS should include different ranges that indicate how frequency may vary following contingency events and the expected trajectory and timeline for recovery of the frequency following contingency events. Clause 2.2.1 of the Technical Rules specifies the frequency variations that may occur in the SWIS, with Table 2.1 specifying the FOS.

3.3.1 Current issue

The FOS are an important input for AEMO in its role as the System Operator. The limits specified in the FOS help define the actions that AEMO may need to take to ensure the secure operation of the SWIS. Actions could include deciding on the type and amount of essential system services required and whether there is a need to adjust generation dispatch to increase the amount of service available.

As part of the broader market reforms, AEMO has led a review of the FOS for the SWIS. The outcome is that the WEM FOS now appears in the WEM Rules. The WEM FOS applies for the intact SWIS and islands, excluding embedded systems (not owned by Western Power).[8]

[8] Energy Transformation Taskforce, *Revising Operating Standards in the SWIS: Information Paper*, November 2019, p. 10.

If the frequency requirements in section 2.2.1 of the Technical Rules are not amended, there is a risk these requirements will not align with the new WEM FOS arrangements. The requirements would be duplicative and potentially cause confusion.

3.3.2 Solution options & preferred solution

Western Power has considered the following options to address these issues:

a) Amending clause 2.2.1 of the Technical Rules to refer to the FOS outlined in the WEM Rules.

b) Amending clause 2.2.1 of the Technical Rules to specify the same frequency requirements as applies in the WEM Rules.

Western Power recommends changes consistent with option a). Amending clause 2.2.1 of the Technical Rules to refer to the FOS outlined in the WEM Rules avoids duplication and any potential confusion. The WEM Rule FOS would apply to the power system when operating as a single interconnected system or as one or more islanded systems created by disconnecting one or more transmission elements.

3.4 Transmission voltage limits

Controlling the voltage on the transmission network to within acceptable limits is essential to maintaining power system security. It is, therefore, crucial that the acceptable transmission voltage limits are clearly defined to help guide efficient planning and operational decisions.

3.4.1 Current issues

Western Power identified the following issues with the definition of transmission voltage limits in the Technical Rules:

- Voltage limits for the transmission and distribution systems are specified in the same clauses of the Technical Rules making it harder to clearly identify the transmission voltage limits.
- Vague terminology is used that may lead to a lack of consistency in the way the limits are interpreted. Key concerns include:
  - The existing drafting leaves open to interpretation the timeframes over which particular voltage limits needed to be achieved, and over what timeframe the voltage should return to the steady state level following a contingency. For instance, the existing voltage step change limits do not specify the timeframe over which the step change should be measured and what control actions should be assumed to act to keep step changes within the specified limits. It is unclear how transformer tapping and switching of reactive plant is to be considered in assessing compliance with the voltage step change limits.
  - Limits are specified for temporary over-voltages, but there is a lack of information regarding acceptable limits for temporary under-voltages.
  - The specification of voltage step change limits contains superfluous information such as the switching frequencies that are unlikely to be experienced on the transmission system.
- The specification of the same voltage limits for operational and planning timeframes is inappropriate as it does not provide a sufficient incentive in planning timeframes to make prudent investments that will ensure voltage limits can be met in operations timeframes. The range of system conditions that can be experienced in operational timeframes is likely to be more diverse that the conditions studies when making planning decisions in planning timeframes. It is generally appropriate that the limits required to be achieved in planning timeframes are more arduous than those applicable in operational

timeframes. This approach builds sufficient capacity into the power system to cope with the range of conditions faced operationally.

Imprecise specification of voltage performance can impede the ability to monitor and compare actual performance against the system standards. A more precise definition of acceptable voltage limits will allow greater precision in the estimation of transfer limits and should help reduce the need for conservative transfer limits that build in margins that account for uncertainty in the performance requirements.

3.4.2 Solution options & preferred solution

The primary solution adopted was to restructure the Technical Rules, creating section 2.2.2 to specify the transmission system voltage performance standards. The various subsections within section 2.2.2 of the proposed Technical Rules incorporate revisions to address each of the identified issues:

- Section 2.2.2.1 of the proposed Technical Rules specifies the timeline from the occurrence of a disturbance to the return to steady state voltage conditions. The section includes information on the control actions that are likely to be active over each stage of the timeline. The information in this section is utilised in the remaining subsections of section 2.2.2 to provide better clarity regarding the specific voltage performance requirements.
- Section 2.2.2.2 of the proposed Technical Rules provides a definition of the criteria that collectively define unacceptable voltage conditions. The criteria consider both pre-event steady state conditions and conditions following disturbances and link to other subsections to provide additional details.
- Section 2.2.2.3 of the proposed Technical Rules specifies limits that should be achieved in steady state conditions prior to a switching event or credible contingency. This section also provides different steady state limits for planning and operational timeframes.
- Section 2.2.2.4 of the proposed Technical Rules specifies limits on the size of voltage step changes following switching or credible contingency. The voltage step change limits defined in this clause are similar to the voltage step change limits specified in the current Technical Rules focussing on frequency of switching likely to be experienced on the transmission system. The step change limits specified are also consistent with the limits specified in revision 2 of the Technical Rules. The change removes ambiguity introduced in drafting changes between revisions 2 and 3 of the Technical Rules. This clause provides added clarity regarding how the voltage step change will be measured by referring to the timeframes defined in clause 2.2.2.1.
- Section 2.2.2.5 of the proposed Technical Rules specifies the voltage limits that apply in steady state conditions following a switching event or credible contingency. The pre-event limits are defined with reference to the timeframes defined in clause 2.2.2.1. The post-event steady state limits in planning timeframes are more arduous than those that apply in operational timeframes
- Section 2.2.2.6 and 2.2.2.7 of the proposed Technical Rules specify transient over and undervoltage limits respectively. These requirements are consistent with current practice, so the proposed changes formalise and make this practice more transparent.

The following subsections provide further elaboration of issues with the existing specification of voltage step change limits in the technical rules and how they have been addressed by the proposed revisions in clause 2.2.2.4.

Voltage step change

Section 2.2.2 of the current Technical Rules sets out the criteria relating to steady state power frequency voltage fluctuations. Clause 2.2.2(b) sets out the limits for voltage step changes resulting from switching operations. Table 3-1 (below) replicates Table 2.2 in the Technical Rules that sets out the voltage step-change limits that apply under clause 2.2.2(b).

Western Power has identified several issues with the current drafting of clause 2.2.2(b) and Table 2.2 related to:

- The structure of the table,
- Use of asymmetric voltage step-change limits, and
- The specification of voltage step-change limits.

The issues and proposed solutions are discussed below. Further, it is understood that the rows in the table for routine switching were originally extracted from an example in the 2001 version of AS/NZ 61000.3.7.[9] AS/NZ 61000.3.7 is a superseded voltage flicker standard[10], and hence the referenced example is not entirely relevant to clause 2.2.2 which addresses voltage step-change limits. Flicker requirements are outlined separately in clause 2.2.3 of the Technical Rules.

Table 3-1: Step-change voltage limits (Table 2.2. in the Technical Rules)

Cause	Pre-switching (quasi steady-state) and during tap-changing			Post-switching (final steady-state)	
				Transmission	**Distribution**
Routine Switching[1]	r (hour^{-1})	$U_{dyn}^{(3)}/U_N^{(4)}$ (%)		Transmission voltages must be between 110% and 90% of nominal voltage	Must attain previous set point
		Distribution	Transmission		
	r ≤ 1	±4.0%	±3.0%		
	1 < r ≤ 10	±3.0%	±2.5%		
	10 < r ≤ 100	±2.0%	±1.5%		
Infrequent Switching[2]	+6%, –10%			Transmission voltages must be between 110% and 9-% of nominal voltage	Must attain previous set point

Notes:
1. For example, capacitor switching, transformer tap action, motor starting, start-up and shutdown of generating units.
2. For example, tripping of generating units, loads, lines and other components.
3. U_{dyn} is the dynamic voltage change which has the same meaning as in AS/NZS 61000.3.7.
4. U_N is the nominal voltage.

Structure of Table 2.2 (step-change voltage limits)

The structure of Table 2.2 of the Technical Rules introduces the following concerns:

9 *AS/NZS 61000.3.7:2001*, Table 7 (Emission limits for voltage changes in function of the number of changes per hour), p. 14.
Table 7 gives the maximum voltage change $\Delta U_{dyn} / U_N$ for normal operating conditions (expressed in per cent of the actual voltage) a customer may cause, depending on the repetition frequency of these changes.

10 *AS/NZS 61000.3.7:2001 Electromagnetic Compatibility (EMC) Limits – Assessment of emission limits for fluctuating loads in MV and HV power systems (IEC 61000-3-7:1996, MOD)* "proposes a set of principles which are intended to be used to determine the requirements for connecting large fluctuating loads (producing flicker) to public power systems. This Standard provides guidance on engineering practices which will ensure service quality for all connected consumers."
Refer to: https://infostore.saiglobal.com/en-us/standards/as-nzs-61000-3-7-2001-115801_saig_as_as_241952/

- The specified voltage limits differentiate between limits that apply to frequent operational switching and infrequent operational switching. However, there is some ambiguity for contingency events with the current presentation.
- Does not define how the voltage step change is to be measured, specifically whether voltage step changes are measured by comparing the pre-event voltage with that immediately after the event but before transformer tapping. Previous versions of the Technical Rules provided greater clarity regarding the treatment of transformer tap changing.
- Specifies requirements for higher frequency switching events that could conflict with or duplicate requirements for flicker specified in other clauses of the Technical Rules. The current drafting provides limits for very high switching frequencies (up to 100 switching events per hour). Operating the transmission and distribution network seldom requires switching events that occur more frequently than once per hour.

Each of the above issues creates ambiguity, leading to confusion regarding the actual voltage step-change performance to be delivered under different scenarios.

Compared to the voltage step-change limits set out in the Technical Rules, the NER provisions are comparatively simple. Under the NER provisions:

- There is no specific voltage step change limit for routine switching. The voltage flicker standards are used to specify limits for voltage variations resulting from a range of activities including frequent variations in loading or frequent planned switching events.
- The voltage step change limits in the system standards have been considered in setting the voltage disturbance ride through automatic access standard for generators defined in S5.2.5.4 of the NER. The automatic access standard requires generators to ride through a voltage change that returns to within +15% of normal voltage within 20 seconds and -10% of normal voltage within 10 seconds.
- Symmetric step-change limits apply:
  - The maximum limit for voltage variation of +/-5% of the target voltage except as a consequence of a credible contingency event or protected event (NER S5.1.4(b)), and
  - Limits of +/- 10% apply at a connection point except as a consequent of a contingency event (NER S5.1a.4).
- Following contingency events, the voltage can vary to within the transient overvoltage limits that reduce to +10% of normal voltage as the time following the contingency increase to 900 ms. As a consequence of a contingency event, the voltage at a connection point may fall to zero for any period. (NER S5.1a.4)

In the UK, the Security and Quality of Supply Standards (SQSS) specify limits for the voltage step change on the transmission system. The SQSS defines the step change as the difference between the voltage immediately before an event and that at the end of the 'transient time phase' after the event. The 'transient time phase' spans the time taken for the fault to be cleared and for the transient voltage response. Typically, this phase extends from the time of the event for up to 5 seconds. During this time, it is expected that on-load transformer tap changes would not have operated.

The voltage change limits in the SQSS depend on whether the switching event is planned or unplanned. For planned events, the limits also vary with the frequency of the switching activity. The limits range from:

- +6 to -12% of the pre-event voltage for more severe unplanned contingency events,
- +6 to -6% of the pre-event voltage for less severe unplanned contingency events and planned but infrequent switching events, to

- +3 to -3% of the pre-event voltage for planned switching that occurs less frequently than once every 10 minutes, with lower limits applying for more frequent switching.

While the SQSS includes reduced limits for higher frequency voltage step changes, unlike the Technical Rules the SQSS does not specify flicker limits for the transmission system. Flicker limits are specified for connections to the grid through relevant sections of the UK Grid Code.

The Technical Rules for the Horizon Power network adopts similar wording to the current Technical Rules for the SWIS[11]. The voltage step change limits for the regulated power systems in the Northern Territory are specified in the Network Technical Code (NTC). The drafting in the NTC is similar to that which appeared in version 2 of the Technical Rules.

The proposed revisions to clause 2.2.2.4 of the Technical Rules address the issues associated with the structure of Table 2.2 in the current Technical Rules. The proposed revisions:

- operate in conjunction with the timeframes specified in clause 2.2.2.1 to provide greater clarity regarding how the voltage step change should be assessed.
- maintain limits consistent with those currently applied in by Western Power when planning and operating the transmission network[12], and
- specify limits that differentiate between frequent operational switching, infrequent operational switching and contingency events.

As discussed below the proposed revisions retain asymmetrical step change limits.

Use of asymmetric voltage step-change limits in Table 2.2

Wester Power considered the following options regarding the asymmetric limits:

a) Adopt symmetrical limits for both frequent operational switching, infrequent operational switching and credible contingencies.

b) Retain the existing asymmetrical limits for infrequent operational switching and credible contingencies.

On balance, Western Power has decided to recommend option b). Option b) retains consistency between the Technical Rules for the SWIS and those applicable for the Horizon Power network. It also retains consistency with the historic practice adopted in planning the SWIS.

While symmetrical limits apply in the NEM (+/- 10% except where varied by jurisdictional regulations, e.g., Queensland[13]), the UK adopts asymmetrical limits (similar to the old CBEMA curves)[14]. As such retention of asymmetric voltage step change limits is not inconsistent with practice in other jurisdictions.

The original Computer Business Equipment Manufacturers Association (CBEMA) curve developed in the 1970s to indicate the sensitivity of computer equipment adopted asymmetrical limits (+6% and -13%)[15], indicating customer equipment was more susceptible to higher rather than lower voltages. The revised CBEMA curve published in 2000 adopts symmetrical limits (+/- 10%)[16], which suggests that modern

11 Horizon Power, Technical Rules, 5 August 2020, Table 2.3, p. 19.

12 For clarity, the current Technical Rules require the Network Service Provider to plan the network so that is operable, with the operating limits being those in section 2.2. To achieve compliance, Western Power typically plans the network to slightly tighter limits than required in section 2.2 so that operations can achieve the stated limits.

13 Clause 13 of the Queensland Electricity Regulations, 2006 require a voltage change of less than +/- 6%

14 Refer to Table 6.1 in Section 6.3 of the NETS SQSS, which outlines in pre-fault voltage steady state voltage limits and requirements in planning timescales that apply onshore transmission.

15 'CBEMA CURVE – THE POWER ACCEPTABILITY CURVE FOR COMPUTER BUSINESS EQUIPMENT', 3 April 2011, accessed 10 April 2020. Refer to: Refer to: http://www.powerqualityworld.com/2011/04/cbema-curve-power-quality-standard.html

16 'ITIC Curve', [undated[, accessed 10 April 2020. Refer to: http://voltage-disturbance.com/voltage-quality/itic-curve/

customer equipment may not be as susceptible to higher voltages. However, if there is doubt over the susceptibility of customer equipment, and in the absence of further analysis on the impact for customers, the existing asymmetrical limits should be retained to avoid any potential for adverse impact on customer equipment. Hence, option b), which keeps the asymmetric limits, is preferred.

Specification of voltage step-change limits

Voltage limits can be specified in several ways. The current drafting of the Technical Rules defines voltage step change limits with reference to the nominal voltage. In contrast, the limits are specified in the NEM are with respect to the 'normal' voltage[17], while those in the UK are with respect to the pre-event voltage.

In the NEM, the 'normal' voltage approach allows for different practices between different network operators regarding the typical voltage at a point in their network. That typical voltage is agreed with AEMO and defined as the normal voltage.

In revising the specification of voltage step-change limits in the Technical Rules, Western Power considered the following options for the presentation of voltage step change limits:

a) Limits specified with respect to nominal voltage.

b) Limits specified with respect to normal voltage (i.e., the NEM approach).

c) Steady state voltage range specified with respect to nominal voltage and voltage step change specified as the change from the pre-switching voltage, with the permissible threshold expressed as a percentage of the nominal voltage.

Option a) is recommended. This option aligns with the approach adopted historically by Western Power when planning the network and reflected in the current Technical Rules. Specifically, nominal voltage is used to specify limits for steady state voltage.

Changing from nominal to 'normal' voltage, as per option b), would have wide-ranging implications that need to be carefully considered, such as the potential impact on customer's equipment. While adopting this approach may allow for the voltage limits at connection points to be better aligned with the actual voltage at the connection point, Western Power does not recommend a change in terminology at this point.

In implementing option a), the voltage step change provisions will clarify that the voltage step change is measured by comparing the pre- and post-switching voltages. This will aid in consistent assessment of the voltage step change requirement. Specifying the required step change limit as a percentage of the nominal voltage means that the step change limit does not change as the even if the pre-event voltage varies. This is appropriate and provides a consistent threshold for all Users connected at the same voltage level. Retaining the limit for steady state voltage to be within a specified range of nominal voltage will mean that level of steady state voltage variation experienced by customers does not exceed historical levels.

3.5 Distribution voltage limits

Like for transmission voltage limits, distribution voltage limits play a role in ensuring the power system operates securely and reliably. The acceptable distribution voltage limits must be clearly defined to help guide efficient planning and operational decisions.

[17] In the NEM, 'normal voltage' means, in respect of a connection point, its nominal voltage or such other voltage up to 10% higher or lower than the nominal voltage, as approved by AEMO, for that connection point at the request of the Network Service Provider who provides the connection to the power system.

3.5.1 Current issues

Western Power identified the following issues with the definition of distribution voltage limits in the Technical Rules:

- Voltage limits for both the transmission and distribution network are specified in the same clauses of the Technical Rules which makes it harder to clearly identify the transmission voltage limits.
- Vague terminology that could be interpreted and applied in many ways leading to lack of consistency regarding the required level of performance.
- The specification of low voltage performance should allow for changes to relevant Australian Standards and the potential adoption of a 230 V nominal voltage on the low voltage distribution system.
- Adopting limits consistent with the relevant Australian Standard will allow a slightly wider variation in the voltages on the low voltage network. This should not adversely impact consumers as equipment is designed to operate with voltage consistent with the Australian Standard. This approach will, however, mean that some network investments can be deferred reducing costs for customers.
- Imprecise specification of voltage performance can impede the ability to monitor and compare actual performance against the system standards.

Other Australian jurisdictions have adopted wider limits including those specified in the Australian Standards (AS 61000.3.100) for voltages. A widening of the voltage range will allow Western Power to connect more residential scale solar PV systems.

3.5.2 Solution options & preferred solution

The primary solution adopted was to restructure the Technical Rules, creating section 2.2.3 of the proposed Technical Rules to specify the distribution system voltage performance standards. The various subsections with section 2.2.3 of the proposed Technical Rules incorporate revisions to address each of the identified issues:

- Section 2.2.3.1 of the proposed Technical Rules specifies the steady state voltage limits for the distribution network. This clause maintains consistency with the limits specified in the current Technical Rules for the distribution network voltage greater than 1 kV. A new table has been added which expresses the steady state voltage limits for the LV (<1 kV) distribution network. The specified limits align with those in the relevant Australian Standard AS 61000.3.100 (2011). This positions Western Power to migrate to 230 V as the nominal voltage for the low voltage distribution network.
- Section 2.2.3.2 of the proposed Technical Rules specifies limits on the size of voltage step changes following switching or contingency events. The voltage step change limits defined in this clause are similar to the voltage step change limits specified in the current Technical Rules focussing on frequency of switching likely to be experienced on the distribution system and consistent with current practice. This clause provides added clarity regarding how the voltage step change will be measured by referring to the timeframes defined in clause 2.2.2.1.
- Section 2.2.2.4 of the proposed Technical Rules specifies the transient overvoltage limits for the distribution network. This section provides limits for the portions of the distribution network operating at greater than 1 kV and separate limits for the low voltage distribution network. A separate low voltage transient overvoltage limit is required to ensure consistency between that limit and the steady state voltage limit which each being expressed in volts rather than a percentage of nominal voltage. This approach allows for the eventual migration from a nominal voltage of 240 V to 230 V for the low voltage distribution network.

3.6 Transient stability

Rotor angle transient stability considers the ability of a synchronous generator to remain synchronised to the rest of the power system following a disturbance. Clause 2.2.7 of the Technical Rules specifies that all generating units with a rated capacity of 10 MW or more must not lose synchronism following a credible contingency event. This clause is focused on one aspect of transient stability that is particularly relevant to synchronous generators.

3.6.1 Current issues

With the majority of new generation connecting to the power system being non-synchronous renewable generating systems, it is important that the system standards consider all relevant forms of aspects of transient stability and not just rotor angle stability.

3.6.2 Solution options & preferred solution

Western Power considered the following options to address this issue:

a) Revise clause 2.2.8 of the Technical Rules by replacing the reference to rotor angle stability with a broader requirement that the power system must achieve transient stability for any disturbance resulting from a credible contingency. Noting that transient stability is achieved if the power system is able to reach an acceptable steady state condition following a disturbance.

b) Revising clause 2.2.8 of the Technical Rules to list various facets of transient stability and requiring the power system to avoid transient instability following a credible contingency event.

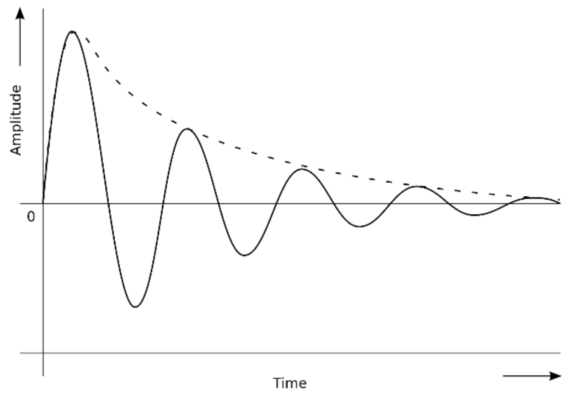
c) No change.

Option a) is recommended. Drafting consistent with this option expresses the underlying technical requirement in a more generalised manner, which means it is better able to capture current any emerging transient stability concerns.

3.7 Oscillatory stability and damping

The system performance oscillatory stability and damping requirements are set out in clause 2.2.8 of the Technical Rules. Damping in this context refers to the ability of control systems on generating systems to quickly reduce the magnitude of any oscillations in key system quantities such as active power, reactive power and voltage, following a disturbance and the ability for the system to return to a steady state free of oscillations, as illustrated in Figure 3-1.

Figure 3-1: Damping of oscillations

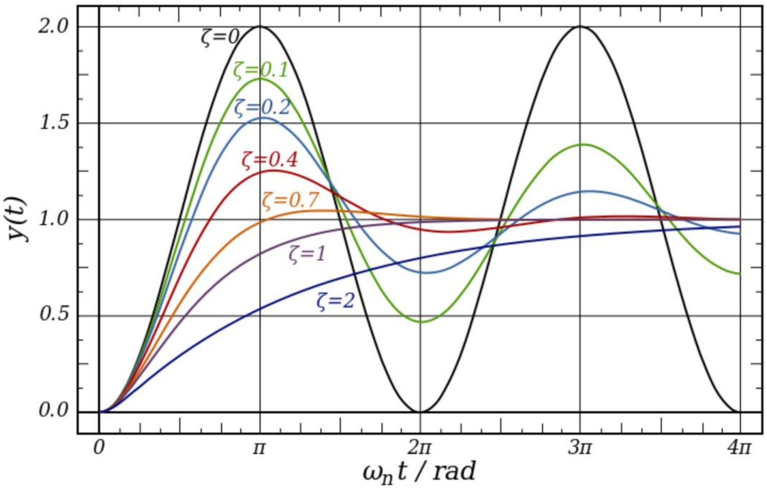


3.7.1 Current issue

The current drafting of the Technical Rules does not consider all forms of oscillations that could be present on a power system. The drafting focuses on system oscillation originating from electro-mechanical characteristics, electro-magnetic effects or the non-linearity of system components. The drafting does not consider other oscillations such as voltage oscillations that may arise through interactions between inverter connected renewable generators particularly in areas of low system strength.

The approach used in the Technical Rules defines adequate damping by specifying limits on the damping ratio for all electromechanical oscillations regardless of the frequency of the oscillation. Figure illustrated how the damping of a second-order system improves with increasing damping ratio.

Figure 3-2: Illustration of damping of a second-order system with different damping ratios[18]



This approach has created issues with several generators utilising gas turbine technology, as the fixed damping ratio limits are difficult to meet with these generators that have higher frequency modes of oscillation. To meet a fixed damping ratio, the time taken to reduce the magnitude of an oscillation by half is reduced as the natural frequency of the oscillatory mode increases.

In addition to the damping ratio requirement, the Technical Rules also require that the halving time of any electro-mechanical oscillation should not exceed 5 seconds.

In the NEM, a halving time is used to specify adequate damping requirements for frequencies of oscillation corresponding to electromechanical modes (Box 3-1). The advantage of using the halving time approach is it specifies a characteristic that can be readily observed via measurement. This is reflected in clause S5.1.8 of the NER that specifies how damping is to be assessed from measurements made on the power system.

The approach adopted in the National Electricity Transmission System (NETS) in the UK is different again. The NETS Security and Quality of Supply Standard (SQSS)[19] defines poor damping of electromechanical modes by the time constant of the slowest mode. Under the definition for system instability, poor damping is described as being where electromechanical oscillations of generating units are such that the resultant peak deviations in machine rotor angle and/or speed at the end of a 20 second period remain in excess of 15% of the peak deviations at the outset (i.e., the time constant of the slowest mode of oscillation exceeds 12 seconds).[20] While the approach in the SQSS is different to that in the NEM, both approaches provide a

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18 Refer to: https://en.m.wikipedia.org/wiki/File:2nd_Order_Damping_Ratios.svg

19 The Security and Quality of Supply Standard (SQSS) sets out the criteria and methodology for planning and operating the National Electricity Transmission System (NETS). Refer to: https://www.nationalgrideso.com/industry-information/codes/security-and-quality-supply-standards

20 *National Electricity Transmission System Security and Quality of Supply Standard*, Version 2.4, 1 April 2019, p. 72.

level of performance that is easily measured and related to the decay measured over time which is independent of the natural frequency of the oscillation.

Box 3-1: Damping in the NEM

In the NEM, the term 'adequately damped' is defined in the NER as follows.

> *In relation to a control system, when tested with a step change of a feedback input or corresponding reference, or otherwise observed, any oscillatory response at a frequency of:*
>
> *(a) 0.05 Hz or less, has a damping ratio of at least 0.4;*
>
> *(b) between 0.05 Hz and 0.6 Hz, has a halving time of 5 seconds or less (equivalent to a damping coefficient –0.14 nepers per second or less); and*
>
> *(c) 0.6 Hz or more, has a damping ratio of at least 0.05 in relation to a minimum access standard and a damping ratio of at least 0.1 otherwise.*

Clause S5.1.8 of the NER outlines the requirement for electromechanical mode damping. Clause S5.1.8 states:

> *In conforming with the requirements of the system standards, the following criteria must be used by Network Service Providers for both planning and operation:*
>
> *……*
>
> *Damping of power system oscillations must be assessed for planning purposes according to the design criteria which states that power system damping is considered adequate if after the most critical credible contingency event or any protected event, simulations calibrated against past performance indicate that the halving time of the least damped electromechanical mode of oscillation is not more than five seconds.*
>
> *To assess the damping of power system oscillations during operation, or when analysing results of tests such as those carried out under clause 5.7.7 of the Rules, the Network Service Provider must take into account statistical effects. Therefore, the power system damping operational performance criterion is that at a given operating point, real-time monitoring or available test results show that there is less than a 10 percent probability that the halving time of the least damped mode of oscillation will exceed ten seconds, and that the average halving time of the least damped mode of oscillation is not more than five seconds.*

Clause S5.1a.3 of the NER then sets out the system stability requirements as including the following:

> *The halving time of any inter-regional or intra-regional oscillation, being the time for the amplitude of an oscillation to reduce by half, should be less than 10 seconds. To allow for planning and operational uncertainties, the power system should be planned and operated to achieve a halving time of 5 seconds.*

3.7.2 Solution options & preferred solution

Western Power proposes revisions to the oscillatory stability requirements now specified in clause 2.2.9 of the Technical Rules to clarify that oscillatory stability requirements apply to all forms of power system oscillations, not just electromechanical oscillations. The requirement should be that all oscillations are adequately damped with the term "adequately damped" being defined in the glossary.

In addition, the following options were considered for improving the specification of the required damping of oscillations:

a) Adopt the NEM approach that specifies an electromechanical mode damping requirement as needing to be achieved in a 5-second halving time when planning the network, with a 10-second halving time used to assess whether actual damping of rotor-angle oscillations measured on the power system is sufficient.

b) Retain existing drafting for electro-mechanical modes but change the damping ratio limits to 0.1 to reflect quantities that generators connected to the SWIS can achieve[21], and introduce additional guidance requiring the use of statistical methods to assess damping from test results.

c) Adopt damping provisions similar to those in the UK SQSS that specify a level of damping required to be achieved in 20 seconds.

Western Power proposes amendments that reflect option b). This approach maintains consistency with historical practice by continuing to specify the required performance in terms of the minimum acceptable damping ratio. With the specified minimum damping ratio set a 0.1, generators connected to the SWIS should be able to meet the specified damping requirement.

The revised clause also specifies that test results used to assess damping must take into account statistical effects, which aligns with contemporary practice in the NEM. The revised drafting requires that to demonstrate compliance with the damping requirements, real time monitoring or test results must show that there is less than a 10 percent probability that the *halving time* of the least damped mode of oscillation will exceed ten seconds, and that the average *halving time* of the least damped mode of oscillation is not more than five seconds. The inclusion of this additional guidance will assist Users to understand how tests to demonstrate adequate damping should be conducted.

3.8 Voltage stability

Voltage stability is the ability of the power system to maintain or recover voltage magnitudes to acceptable levels following a contingency event. Instability would result in voltage magnitudes in part of the power system exhibiting an uncontrolled sustained increase or decrease over time (a “run-away” condition) or sustained or undamped oscillatory behaviour. Voltage instability can occur rapidly (over seconds) or slowly (over minutes).[22]

3.8.1 Current issue

Clause 2.2.9 the Technical Rules defines short-term voltage stability and requires that a stable voltage be maintained following the most severe credible contingency event. The current drafting provides no clear link between achieving voltage stability and operating within the voltage limits specified in the earlier clauses of chapter 2. This lack of alignment creates difficulty when assessing voltage stability.

3.8.2 Solution options & preferred solution

Clause 2.2.10 in the proposed Technical Rules addresses voltage stability requirements. Western Power has proposed revisions to this clause which identify that to achieve voltage stability, the voltage must be maintained within the limits specified in revised clauses 2.2.2 and 2.2.3. In addition, the proposed clause requires that sufficient static and dynamic reactive power capability be available to maintain steady state voltage control allowing for credible variations in load and generation patterns and reasonable variations in the availability of reactive equipment.

The proposed drafting of clause 2.2.10 provides sufficient specification of voltage stability requirements which means that it is no longer necessary to have separate clauses that articulate short-term and long-term voltage stability standards.

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21 Derogations granted that relax the damping ratio for generators include those for Muja D, Kwinana HEGTs, Kwinana Donaldson Road Power stations Units 1 and 2. For the full list of derogations refer to: https://www.erawa.com.au/cproot/21003/2/Western-Power-s-list-of-customer-exemptions---December-2019.PDF

22 AEMO, *Power system stability guidelines* [for the NEM], version 1.0, 25 May 2012, p. 12.

3.9 Network Service Provider obligations – stability and modelling

The Network Service Provider obligations relating to the assessment of power system stability and dynamic performance are specified in clause 2.3.7 of the Technical Rules.

3.9.1 Current issue

Western Power identified the following issues with the drafting of clause 2.3.7 of the Technical Rules:

- The current drafting requires the Network Service Provider to use dynamic models of power system facilities to undertake the studies required to assess power system stability. However, it does not provide any clarity regarding the quality and functionality of the models. This lack of clarity can lead to uncertainty for Users in assessing the effort required to produce acceptable models for their facilities.
- The current drafting contains elaborate provisions that attempt to define how system stability studies should be undertaken by the Network Service Provider. The current drafting is difficult to interpret, does not reflect the complete set of studies that the Network Service Provider may need to undertake and is unnecessarily prescriptive.

3.9.2 Solution options & preferred solution

Western Power has considered the following options to address these issues:

a) Introduce two new clauses:

   i) Clause 2.3.5.1 that establishes requirements on the Network Service Provider to produce generator and load model guidelines and defines the high-level purpose for the guidelines. The guidelines should be consistent with the relevant generation system model procedure specified in the WEM Rules.

   ii) Clause 2.3.5.2 that specifies the stability and modelling obligations for the Network Service Provider including requirements to:

      A) plan design and construct the transmission and distribution system to meet the stability standards specified in section 2.2 of the Technical Rules.

      B) complete sufficient simulation studies to assess power system stability.

      C) utilise models developed in accordance with the generator load and model guidelines to assess system stability.

b) Option a) with the new clause 2.3.5.1 expanded to provide specific modelling requirements that need to be included in the guideline.

c) Option b) with the new clause 2.3.5.2 expanded significantly to provide more prescriptive and elaborate drafting of the approach the Network Service Provider should follow when undertaken system studies to assess power system stability.

Option a) is preferred. This approach provides a definite obligation from Western Power to maintain the existing load and generator modelling guidelines, which is an important document that helps Users understand the modelled requirements they need to meet. The approach also places clear obligations on the Western Power to make appropriate assessments of system stability while avoiding including unnecessarily prescriptive requirements regarding how the stability assessments are to be made.

Option a) is consistent with contemporary practice. In the NEM, the NER places a requirement on AEMO to develop power system modelling guidelines but avoids overly prescriptive drafting that would be required to define in detail the information that is included in the guidelines. The NER also places obligations of transmission network service providers and AEMO to assess system stability but does not include prescriptive provisions defining in detail how such studies should be undertaken.

Options b) and c) do not fully address the issue regarding the unnecessary level of prescription in the current Technical Rules. Removal of this prescription retains the purpose of the Technical Rules and enables greater flexibility in approach where required.

3.10 Network Service Provider obligations – transfer limits

Clause 2.3.7 of the Technical Rules places obligations on the Network Service Provider to determine power transfer limits.

3.10.1 Current issue

The obligations to determine power transfer limits need to be revised to align with the requirements that have been added to the WEM Rules that address the requirement for the Western Power to supply AEMO with network transfer limits.

3.10.2 Solution options & preferred solution

Western Power has proposed revised drafting for clause 2.3.6. Proposed changes require the Network Service Provider to determine power transfer limits and further clarifies that the limits must be produced in accordance with the relevant procedure defined in the WEM Rules and provided to AEMO.

3.11 Network Service Provider obligations – power system performance

Clause 2.3.9 of the Technical Rules places obligations on the Network Service Provider to determine monitor the performance of the power system on an ongoing basis.

3.11.1 Current issue

While the current drafting requires the Network Service Provider to monitor power system performance, it does not include a specific obligation on the Network Service Provider to install sufficient monitoring systems to achieve the required monitoring of power system performance.

3.11.2 Solution options & preferred solution

Western Power has proposed revised drafting for this clause that places a specific obligation on the Network Service Provider to ensure sufficient monitoring is in place. This revision removes any ambiguity and clarifies that Western Power should install the monitoring equipment required to monitor power system performance.

3.12 Network Service Provider obligations – system restart

Sufficient facilities must exist at all times to restart the power system if required. A successful system restart requires having sufficient control and monitoring in place to be able to establish the necessary transmission corridors to connect generating systems providing restart services and enable those generators to restart the rest of the power system.

3.12.1 Current issue

The Technical Rules currently place no specific obligation on Western Power to support the restart of the power system. This creates potential uncertainty regarding the ability for Western Power to justify investment that might be required to maintain the ability of the transmission and distribution system to support the restart of the SWIS in accordance with the restart plan developed by AEMO.

3.12.2 Solution options & preferred solution

Consistent with obligation in section 3.7 of the WEM Rules, Western Power has proposed including a new clause that places clear obligations on the Network Service Provider to:

- Provide assistance to AEMO to develop the SWIS restart plan, and
- Plan the network to provide the capability required to restart the power system in accordance with the SWIS restart plan.

This is a prudent addition to the Technical Rules that helps ensure appropriate investment in the network is made to maintain expected levels of power system resilience.

3.13 Under-frequency load shedding requirements

Under-frequency load shedding (UFLS) schemes provide an important emergency system protection function design to act quickly to arrest frequency collapse following severe contingency events that result in the disconnection of generation.

In the Technical Rules, clause 2.3.1 and 2.3.2 place requirements on the Network Service Provider to design and install an appropriate UFLS scheme. Clause 2.4 provides prescriptive design requirements for the scheme specifying settings for each stage of the scheme.

3.13.1 Current issue

Table 2.8 of the Technical Rules (repeated below as Table 3-2) provides the required settings for the UFLS scheme and how switchable capacitor banks at substations must be shed.

Table 3-2: Under-frequency load shedding scheme settings for the South West Interconnected Network

Stage	Frequency (Hz)	Time Delay (sec)	Load Shed (%)	Cumulative Load Shed (%)	Capacitor shed (%)	Cumulative Capacitor Shed (%)
1	48.75	0.4	15	15	10	10
2	48.50	0.4	15	30	15	25
3	48.25	0.4	15	45	20	45
4	48.00	0.4	15	60	25	70
5	47.75	0.4	15	75	30	100

Source: Table 2.8 of the Technical Rules

The level of prescription in Technical Rules is much higher than similar provisions in the NER. The NER requirement is for market customers to make 60 per cent of expected demand available for load shedding. This can include load shedding offered as an ancillary service.

During the course of the Technical Rules review, the WEM Rules were also updated to include provisions addressing the design and specification of the SWIS UFLS scheme. The WEM Rules require:

- AEMO to prepare and publish an UFLS requirements document containing the aggregate requirements for the SWIS UFLS scheme taking into account the WEM FOS; and
- Western Power to develop an UFLS specification document setting out how it intends to design and implement an UFLS scheme that will meet the requirements specified in the UFLS requirements document.

In developing options to update the UFLS scheme provisions in the Technical Rules, Western Power considered:

- How the current requirements in the Technical Rules could be revised to provide the flexibility to address the needs of the evolving power system.
- The respective roles for the Network Service Provider and AEMO in designing UFLS schemes and the merit in a collaborative approach.
- How any UFLS settings should align the WEM FOS to provide an appropriate margin to avoid unnecessary load shedding if frequency does not move beyond the single contingency band.
- Changes being implemented in the WEM Rules that define roles for AEMO and Western Power in relation to UFLS.

3.13.2 Solution options & preferred solution

Western Power considered the following options for addressing the above concerns:

a) Replace the prescriptive arrangements in the Technical Rules with a high level obligation on the Network Service Provider to provide a UFLS scheme and coordinate the functional design with AEMO. This option aligns with the revisions implemented in the WEM Rules.

b) In addition to option a) include a clause specifying that the Network Service Provide may require a User to make a portion of their load available for UFLS.

Option b) is preferred as it aligns with the revisions to section 3.6 of the WEM Rules and adopts a more flexible set of requirements that will be better able to adapt to keep pace with changes to the SWIS such as the growing level of distributed energy resources. The clearer requirement for Users to make a portion of their load available for UFLS makes existing practice more transparent.

The provisions implemented in the WEM Rules allow Western Power and AEMO to agree on the functionality of the UFLS scheme. This approach is consistent with current contemporary practice.

In the NEM, work is proceeding to enhance the sophistication of the UFLS schemes to recognise that during daylight hours the location of embedded photovoltaic generation needs to be accounted for to avoid the UFLS scheme tripping generation rather than load. This requires a smarter system, i.e., IT and communications investment. Without this additional intelligence, UFLS schemes may not be effective in arresting under-frequency disturbances during daylight hours. These changes are being pursued by AEMO in collaboration with Network Service Providers without the need of prescriptive provisions in the NER.

Similar issues are emerging in the SWIS and the revised UFLS framework in the WEM rules will enable AEMO and Western Power to investigate and implement appropriate revisions to the SWIS UFLS scheme.

3.14 Network Service Provider Obligation - system strength

System strength is a way of describing how resilient the voltage waveform is to network disturbances such as those caused by a sudden change in load or, generation, the switching of a transmission element, tapping of transformers and various types of network faults.

If a network location is said to be "strong" in terms of system strength, the change in voltage at that location will be relatively unaffected by a nearby disturbance. However, if a location is said to be "weak" in terms of system strength the voltage at that location will be relatively sensitive to a disturbance, resulting in voltage dips that are deeper and more widespread.

Having a pliable voltage waveform is a precondition in which other problems are much more likely to emerge. This includes issues such as power quality and voltage instability, and unstable interactions between inverter-based generators. Thus, understanding the system strength in a network is a useful for understanding and proactively managing power system risks.

3.14.1 Current issue

The Technical Rules do not refer to system strength and do not allocate responsibility for planning the transmission and distribution system to provide sufficient system strength. Appropriate allocation of responsibility would allow the Network Service Provider to transparently assess proposed connections to weaker parts of the network and communicate whether adverse impacts are likely to emerge.

3.14.2 Solution options & preferred solution

The proposed revisions to chapter 3 of the Technical Rules (discussed in section 6 of this submission) strengthen requirements for Users. They include an obligation for Users to provide suitable Electromagnetic Transient (EMT) models to assess whether the available system strength at a connection point is sufficient and for Users to operate their plant stably. As discussed in section 9.1 of this submission, a number of revisions are also proposed to the Attachments to the Technical Rules to complement the changes proposed in the various chapters. One of those changes includes amending Attachments 4 and 9 to require Users to advise the minimum short circuit ratio large inverter connected generating systems and large inverter connected loads require for stable operation.

The proposed WEM Rule changes to introduce the generator performance standards (GPS) framework for transmission connected market generators do not introduce an obligation to manage system strength. As such, Western Power considered whether obligations similar to those in the NER should be introduced via changes to the Technical Rules. The NER provides for:

- Do no harm provisions for connecting generators (NER 5.3.4B) – where generators are assessed as connecting where there is insufficient system strength to support the connection, they are required to install system strength mitigation measures.
- AEMO's periodic review of forecast fault levels at nominated points on the transmission network in each region. If AEMO identifies fault level are below minimum acceptable thresholds, they declare a system strength gap (NER 5.20C)
- Network Service Provider obligations to address declared system strength gaps (NER 5.20C.3)

There are issues with adopting the NEM approach. In practice, gaps have been identified in arrears rather than in advance. Detailed EMT simulations of the power system using models for generators validated via tests performed as part of the commissioning process are increasingly being used to identify system strength issues. These issues are identified in operational timeframes and have generally resulted in significant constraints being imposed on generators while longer term solutions are developed that often involve investment in devices such as synchronous condensers or co-ordinated retuning of control system settings across a number of generating systems. Hence, there is a question as to what framework is best for the SWIS.

The connection process that applies to generators in the SWIS is split across various instruments (Technical Rules, WEM Rules, Applications and Queuing Policy (AQP) etc.). In the NEM, the entire connection process is defined in the NER. The separation of the different aspects of the connection process in the SWIS creates complications in implementing a NEM-style ‘do no harm’ process.

Western Power has identified two potential options to amend the Technical Rules that provide for the Network Service Provider to assess the system strength impacts of the proposed connection of a generator:

a) Introduce a new clause in section 2.3 of the Technical Rules that requires the Network Service Provider to plan and develop the network, including using non-co-optimised essential system services, to provide sufficient system strength to meet the stability requirements defined in the power system standards in section 2.2 and the transmission and distribution system protection requirements defined in section 2.9.

b) Implement a NEM-style framework with revisions to the WEM Rules and Technical Rules to:

   i) introduce a WEM system strength impact assessment guideline

   ii) require the Network Service Provider and AEMO to use that guideline to assess when a proposed generator connection will trigger the need for system strength remediation works, and

   iii) revise the generator connection process to include the negotiation of arrangements to implement the identified remediation works satisfying both AEMO and the Network Service Provider.

c) No change – remain silent on system strength obligations.

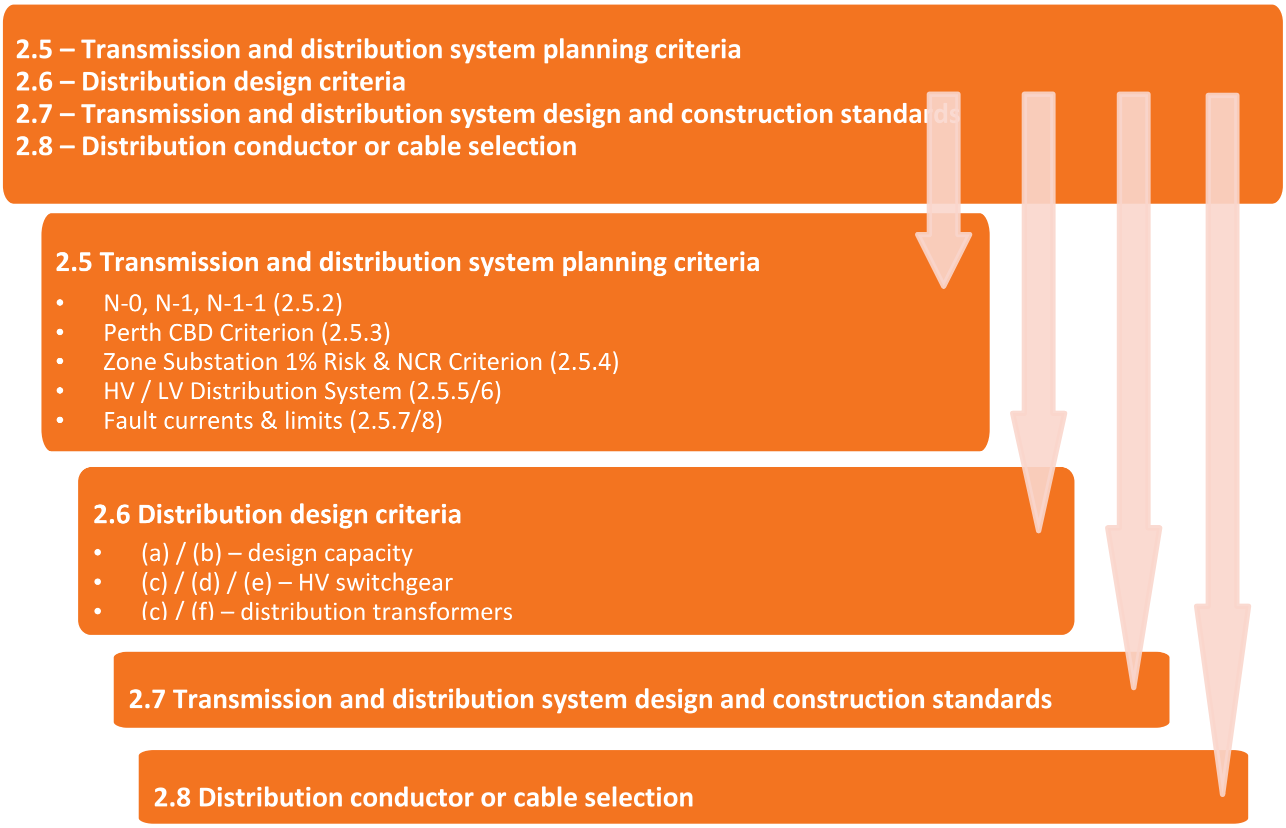
Western Power recommends option a) be implemented This option is most consistent with the existing framework for negotiating connection agreements with generators and agreeing and arrangements needed to fund augmentations necessary to facilitate the connection.

The drafting also recognises expected updates to the WEM Rules that enable Western Power as the Network Operator to trigger a non-co-optimised essential system service process where a need for this service is identified to maintain system strength.

4. Transmission and distribution system planning criteria

The planning and design criteria that apply to Western Power's transmission and distribution network are defined in sections 2.5 to 2.8 of the Technical Rules.

The structure of these sections of the Technical Rules is illustrated in the following diagram.



The limitations, issues and proposed solutions to address issues that have been identified through the Technical Rules review process are discussed in the sub-sections that follow.

4.1 Transmission system planning criteria

The current transmission system planning criteria comprises of four criteria:

- A deterministic N-0, N-1 and N-1-1 criteria,
- The Perth CBD criteria,
- Normal Cyclic Rating (NCR) risk criterion, and
- 1% risk criterion.

The above criteria currently apply when planning and developing the transmission system and were originally adopted in 1996 in the Technical Code, which was developed in accordance with the *Electricity Transmission Regulations 1996,* and subsequently transferred to the Technical Rules in 2007.

The deterministic planning criterion defines acceptable loss of supply (or transfer capability) following the outage of a specified number of transmission elements. The current criterion permits a loss of supply to areas supplied by parts of the network based on the criterion that applies. Table 4-1 includes a summary of the deterministic criterion in the current Technical Rules.

The complete loss of supply to an area is recognised to be onerous for the affected community, especially if it affects essential services. The deterministic criteria are applied with this in mind and with consideration to the important parts of the network where a disturbance could have far reaching impacts across the customer base. The N-0 criterion applies to very small (lightly loaded) and remote parts of the transmission system, the N-1 criterion applies to the majority of the network, and the N-1-1 criterion, which provides a higher degree of security than the N-1 criterion, is applied to the most important parts of the network where an outage could put the system at risk or could affect a large proportion of customers. The N-1-1 criteria is considered when planning:

- all 330 kV transmission lines, substations and power stations;
- all 132 kV terminal stations in the Perth metropolitan area, and Muja power stations 132 kV substation;
- all 132 kV transmission lines that supply a sub-system of the transmission system comprising more than 5 zone substations with total peak load exceeding 400 MVA; and
- all power stations whose total rated export to the transmission system exceeds 600 MW.

A special criterion is specified for the Perth CBD area in recognition of the economic importance of loads located in this small area to the conduct of business throughout the state. This criterion requires that all loads must maintain full supply in the event of any of the following outage combinations:

- One or two transmission lines;
- One or two transformers; or
- One transmission line and one transformer.

As the CBD network does not operate as a paralleled network, it is recognised that load will be lost for a short duration following the unplanned outages. The Technical Rules require that in these circumstances load must be restored within 30 seconds if a single transformer trips. For outages of multiple items of plant, load must be restored within 2 hours.

To comply with the 30 second requirement following loss of a transformer, each substation supplying the Perth CBD area is equipped with an automatic load switching scheme. Feeders and busbars supplying the CBD area must have spare capacity retained to pick up any automatically switched load that can result from a transformer outage.

The 1% Risk and NCR criteria are modifications to the N-1 criterion that accept some additional risk to load security. Both of these criteria are reliant on the availability of spare transformers to be utilised in the event of a transformer failure within a substation.

The 1% Risk Criterion applies to zone substations outside of the Perth metropolitan area (where it is not practical to apply the NCR criterion). The criterion permits the loss of supply to a proportion of a substation’s peak load that is demanded for up to 1% of time in a year (87 hours) following the unplanned outage of any supply transformer in the substation.

Historically, load duration curves have indicated that the top 10% of a substation’s peak load is supplied during 1% of the time through the year and this figure has been used as a general rule in determining substation capacity for 1% risk substations. The capability to develop a probabilistic view of the load expected to be supplied from each individual substation allowed Western Power to apply the 1% Risk Criterion by assessing the load at risk for individual substations.

Both the NCR and 1% risk criteria rely on Western Power being able to share a common supply of spare transformers among a population of supply transformers located at zone substations within the same geographic area.

The NCR risk criterion may be applied by the Network Service Provider to zone substations in the Perth metropolitan area. This criterion is based upon the availability of a mobile rapid response spare transformer (RRST) to be transported to the affected substation and installed in the event of a transformer failure. The target time for installation of a mobile spare transformer is 12 hours. Given travel time, only substations within the Perth metropolitan area are suitable for application of the NCR criterion.

Application of the NCR risk criterion, as envisioned through the Technical Rules, considers the typical load profile seen by transformers within the zone substation where the criterion applies and defines a maximum power transfer level that should avoid premature aging of those transformers assuming that the load on the transformers varies across any day.[23] The variability in load across the day means that the transformers have the opportunity to cool-down during off-peak times and can therefore be loaded more during peak demand periods. Ratings determined taking into account the normal cyclic load pattern are referred to as normal cyclic ratings.

The NCR risk criterion, as defined in the current Technical Rules, attempt to provide for an appropriate level of redundancy in the transformation capacity available at zone substations. The NCR risk criterion requires transformer augmentations be considered once the peak demand on the substation exceeds 75% of the NCR rating. This trigger is delayed compared to that which would be required if the substation was planned to an N-1 criteria but is in advance of the augmentation trigger with an N-0 criteria.

The NCR risk criterion was originally set to 90% as the allowable transfer capacity before augmentation in the 1990's. The policy was introduced to manage capital restrictions[24]. Following the Fitzgerald Inquiry in Queensland (finalised in July 2004)[25], Western Power decided to change to the current 75% NCR trigger as they realised that the 90% trigger created a significant reliability risk under summer peak conditions. The 'NCR wind back' program phased in that change over 10 years to avoid a step change in capital expenditure[26].

A summary of the main elements of the existing transmission planning criteria detailed in sections 2.5.2.1 to 2.5.4.2 of the Technical Rules is presented in Table 4-1.

Table 4-1: Summary of existing transmission planning criteria

Criteria	Description
N-0 Clause 2.5.2.1	Loss of supply to sub-networks occurs following the loss of a transmission element until the failed element has been repaired or replaced.
N-1 Clause 2.5.2.2	No loss of supply to sub-networks occurs following the loss of a transmission element, other than in the case of a zone substation transformer where a brief switching period is allowed.

23 The power transfer capacity of a zone substation (as referred to in clause 2.5.4(b)(2) of the current Technical Rules) is generally the sum of the thermal ratings of the power transformers that transform from the transmission voltage (132kV) to the high voltage distribution voltage (33kV, 22kV or 11kV).

24 Western Power, *Capital and operating expenditure 2009/10 to 20211/12*, September 2008, p. 73. Refer to: 20081008 AAI Appendix 1 - Capital and Operating Expenditure 2009-10 to 2011-12.pdf (erawa.com.au)

25 Electricity Distribution and Service Delivery for the 21st century, prepared for the Queensland Government, July 2004. Refer to: https://www.parliament.qld.gov.au/documents/tableOffice/TabledPapers/2004/5104T1106.pdf

26 Western Power, Appendix 7 - Substantiation of expenditure forecasts, 2006-2009 Access Arrangement, May 2006, p. 60. Available at: http://www.erawa.com.au/cproot/2638/2/AAI-Appendix_7-Expenditures_Report_Pt1-1.pdf

N-1-1 Clause 2.5.2.3	No loss of supply to sub-networks should occur following the loss of a transmission element during the planned outage of another transmission element, for system loads up to 80% of the peak system demand. Principally applies to 330 kV network assets and some high load 132 kV network assets.
Perth CBD Clause 2.5.3	No loss of supply should occur for sub-networks that transfer power to the Perth CBD following the loss of one or two transmission lines or supplying transformers (or combinations). For unplanned outages involving the loss of two transmission elements, an interruption time of 2 hours is allowed.
Zone Substations – 1% risk Clause 2.5.4.1	Permits the loss of supply to that portion of a substation's peak load that is demanded for up to 1% of the year (87 hours). Applies to zone substations outside of the Perth Metro area.
Zone Substations – NCR risk Clause 2.5.4.2	Permits a limited amount of substation demand to be lost until the Rapid Response Spare Transformer (RRST) is installed or the failed transmission element is repaired or replaced. Applies to zone substations in the Perth Metro area.

The current planning criteria is relatively simple and primarily focused on equipment (and equipment outages) rather than the load at risk or the expected value of that load at risk. As technology continues to change and the power system evolves, it is increasingly important for the criteria to focus on factors (such as load at risk) that represent outcomes desired by customers.

The criteria are intended to capture the minimum standards that should be achieved by the transmission system. However, where it is economic to invest beyond this standard, the Network Service Provider is able to justify this expenditure – including through techniques that value load at risk – though the regulatory test and new facilities investment test (NFIT) processes (Box 4-1).

Box 4-1: Summary of the Regulatory Test and New Investment Facilities Test (NFIT)

Regulatory test

In accordance with Chapter 9 of the Access Code, before committing to a major augmentation proposal, Western Power must satisfy the 'regulatory test'.

The regulatory test is satisfied if Western Power demonstrates it has considered all reasonable alternative options, including non-network solutions such as demand-side management or generation, and that its proposed option maximises the net benefit to those who generate, transport and consume energy in Western Power's network.

New facilities investment test (NFIT)

The NFIT is a separate test from the regulatory test and determines that portion of a project that can be financed through the regulated network tariff (i.e., the costs that may be rolled into the regulated capital base and therefore financed through network tariffs applying to all new work users).

Under section 6.52 of the Access Code, a new facilities investment satisfies the test if the proposed investment does not exceed the amount that would be invested by a service provider efficiently minimising costs and must satisfy at least one or more of the following benefit conditions:

- the investment generates enough revenue to cover the investment costs; or
- the investment provides a net benefit to justify higher network tariffs; or
- the investment is necessary to maintain the safety or reliability of the network or its ability to provide network services.

Any costs that did not meet the NFIT requirements need to be financed through some means other than through the regulated network tariff, typically through a capital contribution from specific network users. Hence, the NFIT is important in determining the amount of any capital contribution.

In this section, the transmission planning criteria as set out in the Technical Rules is considered. Changes are not proposed to the processes, which sit outside the Technical Rules, used to justify network investments. However, this context is considered where it is appropriate to make links between these processes.

4.1.1 Current issues

Issues and opportunities for improvement identified through the Technical Rules review process ranged from more minor issues such as ambiguity of terms through to fundamental gaps, such as an inherent lack of flexibility in the current criterion to respond to changed load flows on the network. The main issues and opportunities are outlined below.

Lack of flexibility to respond to changes in demand

The Technical Rules provide for different parts of the transmission network to be designed to different levels of reliability. The intent is to provide higher integrity to the more important parts of the network where a failure could result in system collapse, or where a disturbance could have far reaching impacts across the customer base.

A concern with the current approach is that static measures are used to identify which groups of network assets are most important and should be planned to meet a particular criterion. Key examples of static measures include:

- The transmission voltage being relied on as a primary means of deciding which parts of the network are planned to the N-1-1 criteria, and
- The geographic location of substation being used to decide whether they are planned to an NCR or N-1 criteria.

Historically, the importance of parts of the network can change over time and this is not reflected in static measures. Over a long period of time, this results in less efficient investment than would overwise occur if demand levels were considered because:

- Some substations that supply a higher amount of demand are planned to a lower level of security than asset supplying a lower amount of demand. For example, some zone substations could be designed to a notionally lower standard using the NCR risk or 1% risk criterions despite supplying a higher load than some N-1 designed substations.
- Other assets are underutilised but still attract a higher security planning criterion. For example, the N-1-1 planning criteria is applied to 330 kV lines and typically requires that three overhead lines are built. In practice, the demand and power flows anticipated on some of the existing lines do not warrant this high security standard.

While some variation is expected in any planning criteria, other jurisdictions have adopted criteria that considers demand levels to provide a more direct measure of importance than relying on the static measures adopted in the Technical Rules[27]. For example, the planning standard[28] that applies to transmission and distribution system operators in Great Britain adopts 'demand groups' as a central theme.

Under the Great Britain planning standard, demand groups are a site or group of sites that collectively take power from the remainder of the system. The security afforded to a demand group varies by the size of the demand group. Higher group demand ranges have incremental and increased security and redundancy

[27] While there is some reference to demand load levels within the current N-0 criterion and N-1-1 criterion clauses of the Technical Rules, demand levels are not a central element of the transmission system planning criteria.

[28] Engineering Recommendation (ER) P2/6 Planning Standard

requirements. This approach recognises that, in general terms, portions of the network supplying larger amounts of load are more critical to system operation and have greater customer impacts.

Additionally, the UK requirements generally apply to group demands within the stipulated ranges whether the demand is located within an urban, rural or semi-urban environment. In other words, all customers receive the same level of supply security.

Unachievable restoration times

For clauses that outline supply restoration times there are concerns that the restoration times may not be achievable in all cases and hence are not reflective of current restoration actions and practices.

For example, the NCR risk criteria was introduced as a means of reducing substation augmentation costs compared to the application of a N-1 standard, while providing and acceptable reliability outcome. The reliability outcome is achieved by having a fleet of rapid response spare transformers (RRST) available. Since the NCR criteria was introduced, changes beyond Western Power's control have brought into question whether the RRST fleet can be rapidly deployed (Box 4-2). Hence, it is appropriate to rethink the criteria.

Box 4-2: Factors effecting Western Power's ability to achieve restoration times using RRSTs

Restrictions and reasonable time requirements for deployment of RRSTs are provided below:

- Operational restrictions imposed by Main Roads Western Australia that restrict travel of the RRSTs on public roads to between 9.30am to 3.30pm Monday to Friday, and to daylight hours on weekends.
- Contractor mobilisation to ready the trailers for deployment - The current contract terms provide for 24/7 availability, and a 1-hour response time.
- Deployment readiness, which may take up to 2.5 hours. This includes connection and disconnection of the trailers to and from the prime mover, routine checks and adjustments (required prior, during and after each trip) in accordance with the trailer manufacturer's manual and approved practices.
- Travel to substation sites built to NCR risk criteria, which may take up to three hours. This estimate is based on travel from Forrestfield (where the RRSTs are held when they are not deployed) to Yanchep substation, which is the furthest site from Forrestfield (2 hours in a passenger vehicle +50% factor for the prime mover).
- Site access, connection, commissioning and energisation is estimated to take up to 12 hours once the RRST is on site. This timeframe includes provision for outages that may be required to connect the transformer, including indoor switchboard outages and distribution off-load.

Based on the maximum timeframes specified above for permits, mobilisation, trailer readiness and travel time to site it could take up to 24.5 hours to have the RRST on site (not yet connected, commissioned or energised).

Further, while adoption of the NCR or 1% risk criterion may appear sensible on an individual transformer basis. If multiple transformers are relying on the RRST fleet, there is a risk this fleet is inadequate or not able to be deployed rapidly enough to reach all sites, some of which may be some distance from where the RRST fleet are stored. The available fleet of RRST transformers should therefore be a factor considered when assessing the acceptable number of substations to operate close to NCR limits.

Derogations required for appropriate changes to application of standards

The current requirements and wording do not provide sufficient flexibility to allow Western Power to tailor solution options and adopt a risk-based approach that varies from the Technical Rules, where necessary, without generally seeking a derogation from the Economic Regulation Authority.

While there is some reference to peak load within the N-1-1 criterion (i.e., for 132 kV transmission lines supplying more than five zone substations with total load > 400 MVA), there is no such considerations with respect to 330 kV overhead lines or transformers. For 330 kV overhead lines and transformers, the planning standard typically mandates building three overhead lines or transformers in order to meet the requirements, otherwise a derogation is required.

Since adoption of the current planning criteria, the 330 kV network has been extended into remote regions (including the North Country). The decision to extent the 330 kV network is often justified as the most cost-effective long-term solution taking into account the expected power transfer capacity which is likely to be required over time. In practice, it can take time for the utilisation of those newly constructed assets to reach a level where the added security inherent in an N-1-1 planning standard is appropriate. Western Power considers the suitability of the planning criteria to optimise expenditure in some of these higher voltage assets should be reconsidered.

One example of the need to relax the application of the planning criteria in the technical Rules to avoid inefficient investment is the Meadow Springs Substation exemption from the NCR risk criteria granted in July 2015. This exemption allowed Western Power to avoid inefficient investment recognising the potential uncertainty in the demand forecast and the ability to utilise operational measures to mitigate any supply interruption.

Box 4-3: Meadow Springs zone substation exemption experience

In May 2015, Western Power applied to the ERA for a temporary exemption from complying with NCR risk criteria specified clause 2.5.4(b) of the Technical Rules with respect to the capacity requirements at Meadow Springs zone substation.[29] Western Power sought the exemption from the 2015/16 financial year as it forecast the capacity available at Meadow Springs would be insufficient to meet the requirements specified in clause 2.5.4(b) from that year. The exemption was sought to avoid the cost of bringing forward the planned expansion of the Meadow Springs substation on the grounds that:

- For 2% of the year the forecast demand will be sufficiently high to breach the NCR risk criteria.
- Operational procedures exist to minimise the risk of load not being supplied during periods where the NCR risk criteria of forecast to be exceeded.
- Uncertainty regarding economic development in the area created a risk that demand may not develop as rapidly as forecast. Investing to meet the NCR risk criteria may be inefficient if demand growth does not achieve forecast levels.

On July 2015, the ERA approved an application from Western Power to be temporarily exempted from complying with the requirements of clause 2.5.4(b) (Normal Cyclic Rating Criterion) of the Transmission Planning Criteria in the Technical Rules at Meadow Springs zone substation until the completion of Stage 2 of the Mandurah load area investment strategy, or unless otherwise revoked under the provisions of the Electricity Networks Access Code 2004.

Lack of guidance on generator connections

Noting that the connection of User facilities is planned to enable the User requirements specified in Chapter 3 of the Technical Rules to be achieved, the current transmission planning criteria gives little consideration to the generator connections beyond the requirement to apply the N-1-1 criteria to sub networks for power stations whose total rated export to the transmission system exceeds 600 MW (clause 2.5.2.3(a)(4) of the current Technical Rules). For example, the current Technical Rules do not provide guidance on planning for the loss of generation that may be dispersed or the maximum generation that is

[29] Refer to: https://www.erawa.com.au/electricity/electricity-access/western-power-network/technical-rules/era-determinations-on-exemptions-from-the-technical-rules/meadow-springs-zone-substation-technical-rules-exemption

permissible to be supplied via a single transmission element and therefore at risk of being disconnected by a single contingency or how generation outages might be planned for.

Further, changes to the location of generation on the SWIS means that that the most critical transmission element from a generation connection perspective are changing. Traditionally, there has been little generation connected north of Perth but the development of large-scale renewable generation projects in the North Country region is changing that. In the future the transmission lines running north of Perth will connect a significant amount of generation. Outage of the transmission network north of Perth have the potential to result in a significant loss of generation.

Including appropriate consideration of generator connection requirements in the planning criteria will help ensure that sufficient transmission capacity is provided to efficiently connect new generation while managing power system security.

Lack of scope for risk-based approaches

Although there is a broad consideration and acceptance of differing levels of risk to customer supplies within the design of the current technical criteria, there is no explicit provision for the use of risk-based planning concepts. Energy Policy WA's SWIS Demand Assessment identified significant transmission system investment requirements to support renewables and potentially significant step-changes in demand[30]. The lack of risk-based planning provisions in the current criteria could limit Western Power from planning the network in the most efficient manner, particularly when it comes to prioritising and optimising network investment budgets across multiple potential investment projects that have varying underlying risk considerations.

Additionally, if no consideration is given to such concepts, this can pose issues with respect to unplanned outage events that are not typically covered within the current definition of credible contingencies, i.e., High Impact Low Probability (HILP) events, such as the loss of single double circuit overhead tower line. Such events are unlikely to be explicitly considered within deterministic planning criteria given their low probability of occurrence and, therefore, network planners may not be incentivised to investigate whether there are prudent investment options that would help reduce the impact of HILP events. While it is unlikely that it would be economic to duplicate a transmission line to reduce the impact of a double circuit line outage, it may be economic to implement a wide-area control scheme that rapidly adjusts load and generation in response to such an event to prevent widespread supply disruption that might otherwise occur. Efficient investments that reduce the impact of HILP events are more easily justified if a defined process to identify and value such investments exists within business planning processes.

As part of the Technical Rules revisions, more explicit reference could be made to allow Western Power to adopt risk-based planning concepts. Such considerations would provide additional flexibility and allow Western Power to justify network investments that may not typically fit with the prescribed transmission planning criteria. Alternatively, these same techniques may be used by Western Power to demonstrate that minor deviations from the technical performance or planning criteria can be adequately managed through the proposed mitigation actions and thereby avoid unnecessary capital investment or the need to seek explicit derogations from the Economic Regulation Authority.

Western Power recognises adoption of more explicit risk-based approach to planning would add a level of complexity compared to the current approach. Of importance, the adoption relies on there being sufficient and adequate statistical information to support the required risk analysis. Otherwise, the calculated risks of events occurring could easily be under or over-estimated. In the case of the latter approach, by essentially

30 Energy Policy WA, SWIS Demand Assessment, 17 May 2023. Refer to: https://www.wa.gov.au/government/document-collections/swis-demand-assessment

avoiding any consideration of risk-based planning principles the issues outlined would remain and may continue to be overlooked.

Issues with specific clauses

In addition to the broader identified issues affecting particular elements of the existing transmission planning criteria, a number of specific issues were also identified with the current transmission planning criteria clause (clauses 2.5.2 to 2.5.4) as summarised in Table 4-2 below.

Table 4-2: Issues with specific transmission planning criteria clauses

Criteria	Principal issue(s)
N-0 Clause 2.5.2.1	• Application is unclear for zone substation with peak load > 10 MVA • Clarity is required over terminology definitions
N-1 Clause 2.5.2.2	• Application is unclear for transformer-feeder substation designs, which may lead to inconsistent outcomes. • Clarity is required over the definition of "brief switching period."
N-1-1 Clause 2.5.2.3	• No reference to load levels for 330 kV lines and connections means that all these lines must meet the requirements outlined unless a derogation is sought. • No demarcation in application between Metro and Country areas means some areas are supplied with this high standard when the investment is not necessarily justified based on the load at risk. • The outage conditions listed in Table 2.9 of the current Technical Rules, which lists a series of circumstances when the N-1-1 criteria does not need to be met during an outage, requires review to confirm these are still appropriate. • Clarification of the load levels that should be applied when assessing compliance with the criteria during planned outages.
Perth CBD Clause 2.5.3	• Clarity required around the defined Perth CBD boundary and application to ensure that this reflects current supply arrangements i.e., for substations and feeders supplying load part inside and outside defined boundary. • Review required restoration timeframe requirements to confirm these are still achievable and appropriate.
Zone Subs – 1% Risk Clause 2.5.4.1	• Application of 1% risk criterion questioned, and in particular whether some zone substations outside of the Perth metropolitan area, particularly urban areas, should also be designed to NCR requirements.
Zone Subs – NCR Clause 2.5.4.2	• Significant issues raised around deployment of RRST within defined 12 hour timescales required to apply NCR Criterion – timeframe in practice likely to be significantly longer. • Basis of criterion questioned including whether the standard should be N-1 with divergence to a lower standard based on economic, technical and reliability considerations on a specific case by case basis.

4.1.2 Solution options & preferred solution

There are two broad approaches that can be adopted to address the issues identified above. The first is to re-work and update the current clauses to remove the identified ambiguities, inconsistencies and update application restoration times as necessary to reflect current practice. The second approach is to revise the current planning criteria to make consideration of demand or customer load and its inherent value, the central element uses to select the appropriate planning criteria. The second approach can be achieved in two main ways:

- Using a structured demand or load group approach similar to Great Britain's Engineering Recommendation P2, revision 6 (ER P2/6) standard that stipulates the security requirements for incremental demand values, with the inherent value of customer load being taken into consideration when setting the demand group thresholds.
- By explicitly valuing customer reliability through a value of lost load approach and using this value to determine the optimal technical and economic design of specific substations or sub-networks of the transmission system using risk based or probabilistic techniques.

Thus, Western Power considered the following options:

a) Revise the current transmission planning criteria to introduce a demand group structure to transmission system planning in a similar manner to the ER P2/6 standard that applies in Great Britain, albeit tailored to Western Australian considerations and requirements.

b) Revise the current transmission planning criteria to be fully or partly based on risk-based or probabilistic techniques and the use of value of customer reliability.

c) An approach that is a hybrid of option a) and b) whereby specific planning arrangements and demand groups are adopted akin to the Great Britain approach, but flexibility to deviate from the standard is provided for where economically justified.

d) Minimal change - Retain the existing transmission system planning criteria and update the Technical Rules to address the issues identified with clauses to remove ambiguities, inconsistencies and other out of date terminology and requirements.

Western Power has proposed changes consistent with option c) and the main characteristics of this approach are explained in section 4.1.3 of this submission.

Option c) provides the appropriate balance between increasing the flexibility of approach to ensure efficient long-term investments, while retaining a structured approach that can be more readily adopted by transmission planners working in the SWIS context. The proposed approach:

- Removes the lack of clarity that was present in the current provisions.
- Aligns the updated drafting with the current intention of the Technical Rules to provide for higher security requirements for areas of the network that are more important.
- Is more flexible than the current approach because it allows for different planning standards to be applied as demand and generation locations alter power flows on the system.
- Can cater for known changes to the market including the change to a constrained (non-firm access) environment that is being introduced.

In developing the proposed drafting, Western Power considered the current network capability and considered future market changes. The proposed criteria move away from a planning system solely focusing on equipment types and historical geographic demand centres. The proposed approach will better optimise expenditure in the longer term as the security standards applicable to areas of the network can change as demand changes.

In considering the relative merits of options a), b) and c), Western Power considered the principal advantages and limitations of the demand group approach considered in option a) and a pure risk-based approach contemplated in option b). The advantages and limitations of each approach are summarised in Table 4-3.

Table 4-3: Summary of advantages and limitations of alternative demand based approaches

Approach	Advantages	Limitations
Structured demand groups	• Consistent application across individual demand groups • Clearly identifiable points at which higher security requirements apply • Avoids need to calculate value of customer load reliability in majority of cases • Avoids complex and bespoke risk or probabilistic calculations for which underlying data may not be available • Makes restoration activities in operational timescales easier as requirements are transparent	• Less flexibility to vary requirements within individual demand groups (although not impossible) • Step change in security requirements can occur when incremental movements across demand group scale • Can underestimate true value of customer load reliability, particularly for commercial and industrial customers
Customer reliability value	• Allows individual customer characteristics and load value to be explicitly included in the network design • Flexibility to adopt bespoke substation designs for loads • Avoids step change in security design requirements though small incremental load increases	• Basis for risk and probability calculations may not fully reflect operational considerations and may be less transparent • Requires detailed asset reliability and failure rate statistical data • Requires an explicit means of valuing reliability of supply • Investments for rural and remote areas may never pass economic test but are required to comply with licence conditions • More complex analysis results in investment decisions that are more difficult and costly to independently verify, which can lead to reduced transparency

Reviewing the characteristics outlined Table 4-3, it is evident that each approach has a number of advantages and limitations. However, on balance, Western Power considers the structured demand group approach offers the better starting basis for a planning criterion. Particularly considering the significant change to generation and load observed and expected in the SWIS that must be supported with a holistic, structured yet responsive transmission planning criteria that can guide transmission investment.

Structured demand groups offer a more transparent and simple starting point. Further, the limitations associated with a structured demand group style approach are easier to overcome than those where a customer reliability approach forms the basis the criteria.

The limitations of step change security requirement can be overcome by incorporating some risk based or reliability specific considerations into each demand group. For example, where a small increase in demand at a zone substation resulted in that substation's demand moving into the next demand group range triggering increased supply security requirements, a probabilistic criterion could be applied to defer the need to apply the higher supply security requirements if the considered risk exposure was limited. This could be used as a means to defer capital investment needed to enhance the security of supply for the substation or as a longer term solution if the period of exposure (time spend outside of security requirement) was not expected to increase i.e., if demand was stable or falling.

Based on the above, Western Power proposes changes that reflect a hybrid approach. The function specific planning arrangements and demand groups that form the basis of the proposed criteria are akin to the Great Britain approach, but flexibility is provided to deviate from the standard where there is technical or economic merit. The hybrid approach proposed by Western Power retains the main advantage of structured demand groups approach whilst negating the main limits.

Option d) was not considered sufficient to address issues with more fundamental concern with the current planning criteria. In particular, the continued lack of flexibility to adjust planning standards as use of the systems changes will become increasingly problematic. The transmission planning criteria has dated and requires significant revision so it can enable the appropriate investments required to support the future energy developments in the SWIS.

4.1.3 Proposed transmission system planning criteria

The proposed transmission system planning criteria is based on the demand group structure to transmission system planning outlined in ER P2/6 standard that applies in Great Britain, albeit tailored to Western Australian considerations and requirements. The following sections outline the key components of the proposed criteria, namely:

- Planning is based on functional parts of the transmission system ensuring there are no gaps,
- A formulaic, transparent approach is used that speaks to a more clearly defined set of outages and contingencies,
- Ability to adapt to known future changes to the WEM, and
- Other elements of the planning criteria are maintained so that the approach does not result in a step-change.

These attributes are detailed in the subsequent sections.

Planning based on functional parts of the transmission system

The proposed transmission system planning criteria restructures the requirements for the system in terms of the functional parts of the system, namely:

- Main Interconnected System (MITS) and sub transmission system,
- Generation connections, and
- Demand connections.

This approach ensures there are no gaps and is consistent with the approach adopted in Great Britain.

The **MITS and sub transmission system criteria** applies to the most critical parts of the transmission system. The MITS comprises:

- all 330 kV terminal stations and transmission circuits connected to the 330 kV network by three or more 330 kV circuits;
- all terminal stations providing direct connection to generation in excess of 600 MW (consistent with the existing requirement in clause 2.5.2.3(a)(4)); and
- the transmission circuits connecting 330 kV terminal stations to the terminal stations providing direct connection to generation in excess of 600 MW.

The sub transmission system are the parts of the transmission system that are not part of the MITS.

For the MITS and sub transmission system, the security standard is applied recognises the importance of these parts of the network and that outages on these parts of the network could put the system at risk or could affect a large proportion of customers.

The MITS and sub transmission system require the Network Service Provider to consider the security of power transfers across large portions of the network. For this reason, when outages or faults occur, the potential loss in demand considered naturally results in criteria applicable to the larger demand groups generally being used.[31]

Two background conditions are stipulated in a new Attachment to the proposed Technical Rules that outline the background conditions applicable when planning the MIST and sub transmission systems:

- The System Security Background represents the typical planning assumptions used when applying the planning criteria, such as a worst case demand forecast and a security constrained economic dispatch that is then modified to represent a credible worst case dispatch scenario for the area of the network being investigated. The intent of the System Security Background is to allow the planning of the transmission system to consider a range of credible but challenging future system conditions to ensure that there is sufficient transmission capacity to meet demand reliably and securely across a range of disparate outcomes.
- The System Economy Background is intended to represent the most likely network assumptions and the lowest cost dispatch ignoring any network transfer constraints. This approach is used to identify boundaries that have the potential to lower overall system cost through augmentation. Under the System Economy Background condition, all boundaries identified as constraining the most efficient dispatch outcome must be investigated and monitored to ensure the most efficient outcome between market constraint cost and network transfer capacity augmentation.

Several additional requirements are provided for in the MITS and sub transmission criteria (clause 2.5.5.6 of the proposed Technical Rules) that allow the Network Service Provider to consider constraints[32] as alternative solutions to network and non-network solutions. The role of these provisions in assisting with the transition to a constrained market is discussed below, in the section titled, “Ability to adapt to known future change to the WEM”.

The **demand connection criteria** apply to areas of the system that support demand groups, where demand groups are a site or group of sites that collectively take power from the remainder of the system. The criteria do not replace those Chapter 3 requirements that might require specific design of connection assets to achieve the User’s requirements.

The criteria proposed for demand connections replicate the intention of the original Technical Rules. However, the proposed changes allow for the security standard to flex as the demand on the system changes, leading to more efficient investment outcomes in the long term.

The proposed permitted loss of demand groupings broadly aligns to the existing approach. Rural, Urban and Perth CBD requirements are retained with the security requirements increasing within these broad classifications as the quantity of demand at risk increases. For example, for rural parts of the network and under intact system conditions, the allowable time period for a loss of demand <20 MVA due to a loss of

31 Some areas of the sub transmission system supply regional areas where load is relatively small and the revised planning criteria adapts appropriately for these smaller demand groups.

32 ‘Constraint’ has the meaning given the WEM Rules. As at 1 July 2021, this definition was “(a) a Network Constraint; and (b) a limitation or requirement affecting the capability of a Load or generating system such that it would represent a risk to Power System Security or Power System Reliability if the limitation or requirement was removed.”

transmission circuit credible contingency is the repair time. Whereas the same circumstance but for groups of demand greater than 20 MVA there is no should be no loss of demand.

For the Perth CBD area, the existing restoration times of 2 hours is retained for a contingency event following an existing planned or unplanned local outage and 30 seconds for the outage of a single transformer. As with other functional parts of the network, the contingencies that need to be considered for each demand group is clearly specified so that the system can be efficiently planned and subsequently operated with a clearer understanding of has been catered for. Contingencies defined in the proposed planning criteria are outlined further in sections 4.1.3 and 0 of this submission.

There are newly defined time periods for which permitted demand losses are acceptable:

- repair time is the time taken to repair the fault and restore supply to the area.
- remote switching time is the time it would typically take to carry out remote switching from the Network Service Provider's control centre.
- emergency return to service time is the pre-agreed time to recall a planned outage following an unplanned event.

Where the permitted loss of demand time is stated as 'None', the system should be planned so that no demand is lost. For clarity, this is different from load shedding that may occur if the UFLS scheme is triggered. UFLS scheme load shedding should occur as a last resort and in emergency events, whereas permitted demand losses specified in the proposed transmission system planning criteria are intended to reflect the value of the lost load compared to the costs of avoiding that loss in demand. Group demands have been developed to align with the existing standards and with consideration to the network configurations.

When planning the network, two types of demand losses are considered depending on the level of security to be achieved:

- group demand is used for assessments of the system capability with intact system conditions, and
- maintenance period demand is used for assessments of the system capability with planned and unplanned outage conditions.

The maintenance period demand is, by definition lower than group demand, consistent with the current practices.

The **generation connection criteria** apply to areas of the system that support generation. These areas of the system may support the connection of one or more generators to the remainder of the system and included embedded generation. The criteria do not replace the Chapter 3 requirements that apply to connection assets.

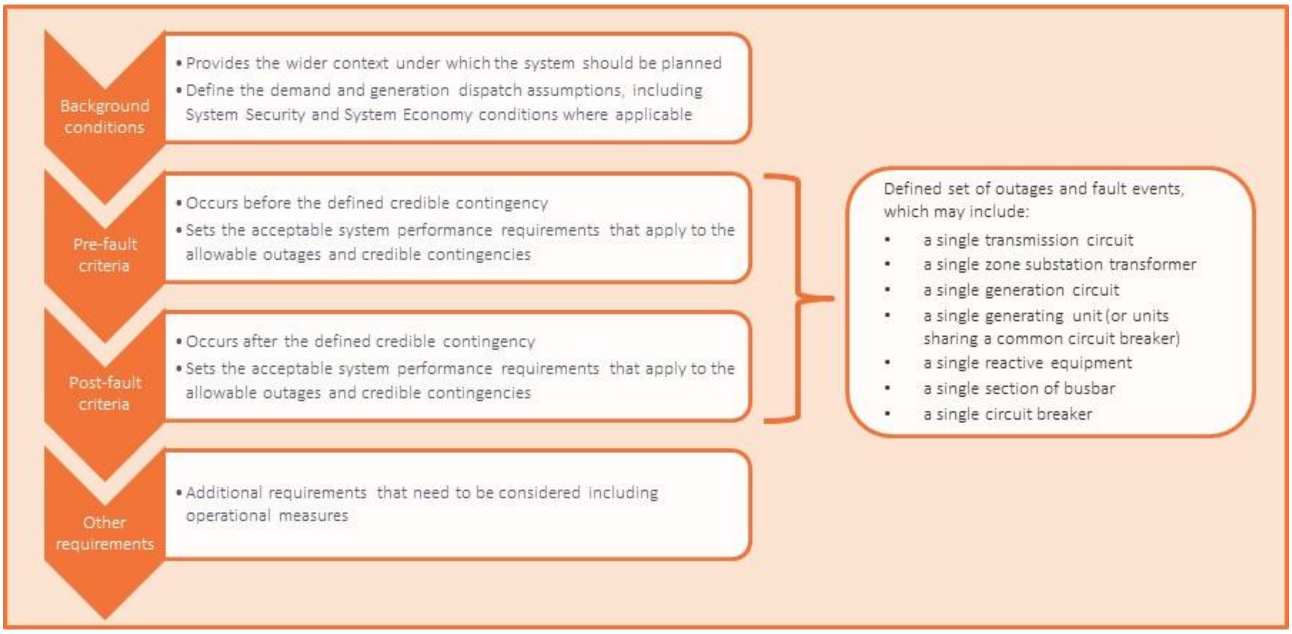
In planning generation connections, the criteria require the Network Service Provider to look at the loss of power infeed that may occur under the set of defined scenarios. The loss of power infeed calculation included in clause 2.5.3.1 of the proposed Technical Rules is intended to calculate the net loss of power during a forecast minimum demand period. In this way, the planning takes an appropriately conservative approach to the risks the system may be exposed to from a network outage that results in a loss of generation.

The maximum infeed loss limit permitted for any part of the transmission system is 400 MW (clause 2.5.3.1(b) of the proposed Technical Rules). This value is lower than the export limit of 600 MW specified in the existing N-1-1 planning criteria (refer to clause 2.5.2.3(a)(4) of the current Technical Rules and clause 2.5.2(b) of the proposed Technical Rules). However, the value of 400 MW is in line with the size of generation contingency which is likely to be able to be accommodated by essential system service available in the WEM. Currently AEMO procures spinning reserve services sufficient to cater for the loss of the largest generating unit. In setting the requirements, Western Power has also considered the historic levels of spinning reserve required and demand available for fast frequency response. Setting the maximum infeed loss at 400 MW is therefore unlikely to impose an unrealistic expectation of the amount of essential system service required.

Further, Western Power proposes the maximum reduction of generation capacity at any single section of busbar during a planned outage should be limited to 150 MW (clause 2.5.3.1(d) of the proposed Technical Rules). This figure is consistent with the current network configuration and is considered a reasonable upper limit given the size of the SWIS.

Formulaic, transparent approach to planning

The proposed transmission system planning criteria provides for a formulaic approach to planning the system. For each functional part of the system (MITS and sub transmission, generation connection, demand connection), background conditions are established, then pre- and post-fault criteria are set out that consider the intact system and the system with a local outage[33]. The outage and contingencies that need to be considered are also clearly articulated.



In each case, the functional part of the system must be planned such that when that part of the system is intact (and pre-fault) there are no:

- equipment loadings exceeding the pre-fault rating;
- unacceptable voltage conditions; or
- system instability.

Following any credible contingency of the types identified in the proposed Technical Rules, the same requirements (no equipment overloading, no unacceptable voltage conditions and no system instability) must also be meet. However, loss of demand is permitted to the extent provided for in specified demand

[33] The exception is generation connections for which local system outage conditions are not applicable.

group. As described in the section above, the time period and conditions under which demand losses are permitted vary based on the size of the demand group at risk.

As discussed further in section 0 of this submission, the proposed transmission system planning criteria provides for a more clearly defined set of outages and credible contingencies. The outages and contingencies listed in in the proposed criteria vary between clauses.

The proposed approach, when implemented, will be consistent with the way the system is being planned. That is Western Power already studies for the above list of outages and faults. However, the revised drafting brings a significantly enhanced level of transparency compared to the previous drafting. This transparency is important as it will enable better consistency across planners, particularly with strategic longer term plans developed through the Whole of System Plan. Enhanced transparency also better allows interested stakeholders to understand the reasons for proposed transmission system investments, which in turn may create opportunities for providers of non-network services to work with Western Power to develop options capability of addressing identified needs.

Flexibility to respond to demand and more efficiently manage the network

Table 2-11 in the proposed Technical Rules outlines the permitted loss of demand following specified credible contingencies. While the table sits within the demand connection section, the table is used when planning all functional aspects of the network when it forms one of the conditions that must be met.

Previously the equipment and geographic specific criteria meant the system was inflexible to changes in demand. With the adoption of the demand groups in Table 2-11, changes in the potential loss of demand being considered for an area will naturally alter the criteria that is applied. For example, if the loss of demand from a contingency event during the planned outage of a transmission circuit in an urban area is greater than 90 MVA but less than 250 MVA, the planner must ensure the maintenance period demand is only unsupplied for the emergency repair return to service time. However, if there was demand growth such that the loss was likely to be greater than 250 MVA, steps would need to be taken to avoid that loss entirely.

The flexibility in responding to demand works in both directions. As the load at risk falls for particular parts of the network, the security planned for naturally adjusts so that when existing assets reach the end of their life these are replaced or managed to achieve the standard appropriate for that new lower demand profile. Importantly, the process allows the planner to manage the network and transfer of demand between groups during outages to make better utilisation of plant and equipment. In this way, consideration of demand transfer capability allows for more efficient outcomes.

The adoption of demand groups provides additional transparency with respect to future network design and investment requirements. Specifically, incremental security and redundancy requirements when moving between demand or load groups can be more easily tied to capital investment plans and an evaluation of the technical (reliability) and economic benefits of doing so to determine if the investment is appropriate.

Ability to adapt to known future change to the WEM

Reforms being progressed by the Western Australian Government are expected to introduce a constrained access regime for the WEM. Users will be allowed to use the access that is available and, should they wish to relieve any of the constraints, they will have the opportunity to do so or the option to be constrained.

The System Economy Background conditions provided for in the proposed Technical Rules directly provides for a future constrained dispatch market environment. This set of background conditions represent the most likely network assumptions and the lowest cost dispatch ignoring any network transfer constraints.

This approach is used to identify boundaries that have the potential to lower overall system cost through augmentation. The changes will enable the Network Service Provider to consider the value of imposing constraints where this is more economically efficient than alternative network and non-network solutions. Consequently, the Technical Rules need to cater for these circumstances.

Other requirements in the MITS and sub transmission criteria have been designed with the move to constrained dispatch in mind. Clause 2.5.5.6(c) of the proposed Technical Rules allows the Network Service Provider to consider network and non-network solutions except where operational measures, including constraints, suffice to meet the criteria.

MITS and the sub transmission criteria are designed to ensure efficient levels of network transfer capability are delivered in a way that minimises the costs to users of the system, while ensuring reliability, adequacy supply. These additional clauses ensure the full range of available options are considered.

Comparison of the new planning criteria to the existing criteria

The intention in moving to the new system is to ensure new transmission developments are appropriate to support the future power requirements of the SWIS. However, to minimise any step-change in capital investment that might be needed to reach alignment across the existing and proposed requirements, the new transmission system planning criteria has been designed to maintain those elements of the existing planning criteria that are still appropriate. To this end, the demand groups have been developed to reflect the existing reliability and network security levels.

- Busbar outages have not been explicitly covered in the planning criteria previously, except under the N-1-1 criteria. The inclusion of busbar outages covers a gap in the existing rules. In practice, the inclusion of busbar outages should not have a significant impact:
  - The rural demand groups in the ≥90 MVA & <250 MVA range should already be able to manage such a fault outage via remote switching, although there may be a need to temporarily loose up to 60 MVA of load, which is consistent with the proposed requirements (refer to the footnotes to the Demand Group table in the proposed Technical Rules).
  - The urban demand groups in the ≥90 MVA & <250 MVA range are likely to be terminal stations, which within the Perth Metro area should already be able to manage such a fault outage via remote switching. Like the proposed treatment for rural demand groups, there may be a need to temporarily loose up to 90 MVA of load. However, this is consistent with the proposed requirements (refer to the footnotes on the Demand Group table in the proposed Technical Rules).

    Western Power has identified one substation where the footnote on the Demand Group table would apply. For Mason Road substation, given the number customer connections and the size of those connections, it would be appropriate to consider a fully compliant (i.e., N-1-1) configuration and this would represent an upgrade.
  - For the Perth CBD, demand groups in the ≥90 MVA & <250 MVA range are only likely to occur on the 132 kV double circuit lines supplying Hay Street or Milligan Street in the case where there is a total loss of supply capacity (N-2 failure) within the other substation e.g. the combined Hay Street and Milligan Street load is supplied on the 132 kV circuits supplying Hay Street (for a loss of infeed at Milligan Street or vice-versa). In this case further fault outages, beyond the occurrence of a N-2 fault that led to the combined Hay St / Milligan St load to supplied via one set of infeeding 132 kV cables, are not considered credible. Hence, a demand group in this range is unlikely to occur in practice within the Perth CBD under intact conditions.

- For the All Areas demand group, the N-1-1 criteria is effectively captured based on demand thresholds rather than an explicit sub-network. The changed approach introduces flexibly as the system needs change. The following areas represent a step-change in the requirement:
  – The 132 kV terminal stations in Perth metropolitan area are already part of the existing N-1-1 criteria requirements. However, it is noted that some existing terminal stations were designed prior to current planning practices and the introduction of the Technical Rules.
  – Large demand groups (>250 MVA but less than 400 MVA) supplied from existing 132 kV zone substations and from terminal substations outside of the Perth Metro area. This change is appropriate and required for future developments. The updated standards are critical to support the scale of future developments expected on the power system.

  For these areas where the existing configuration does not align with the proposed requirements, the flexibility introduced through economic assessment provisions that allow for higher or lower standards to be planned for where economic, enabling the network to remain compliant (including where grandfathering provision remain) whilst providing an opportunity for strategic investments where this is prudent. As such, the increased standards are not expected to result in an immediate step-change in capital investment unless this is critically necessary.

Table 4-4 (below) compares demand groups in the new planning criteria with the existing criteria. Most of the demand groups map to existing planning criteria with no changes to the security requirements. For some demand groups, the new transmission planning criteria appropriately updates the requirements. The following outlines those changes.

- For NCR and 1% risks criterion substations, when taken alone, the new demand groups represent an increase in security. As highlighted in section 4.1.1 of this submission, achieving the NCR criterion for existing substations using RRSTs is challenging. Western Power has historically relied on the NCR criteria and the 1% risk criterion to manage capital restrictions and so these mechanisms represent a misalignment in the security and reliability of the network. As a result, some substations in rural areas of the network with lower demand are afforded a higher reliability standard than urban areas that have higher loads. Under the proposed transmission planning criteria, this misalignment would be corrected for new substations. For existing substations, the flexibility introduced through economic assessment provisions that allow for higher or lower standards to be planned for where economic, enable the existing substations to remain compliant whilst providing an opportunity for strategic investments where this is prudent.
- Busbar outages have not been explicitly covered in the planning criteria previously, except under the N-1-1 criteria. The inclusion of busbar outages covers a gap in the existing rules. In practice, the inclusion of busbar outages should not have a significant impact:
  – The rural demand groups in the ≥90 MVA & <250 MVA range should already be able to manage such a fault outage via remote switching, although there may be a need to temporarily loose up to 60 MVA of load, which is consistent with the proposed requirements (refer to the footnotes to the Demand Group table in the proposed Technical Rules).
  – The urban demand groups in the ≥90 MVA & <250 MVA range are likely to be terminal stations, which within the Perth Metro area should already be able to manage such a fault outage via remote switching. Like the proposed treatment for rural demand groups, there may be a need to temporarily loose up to 90 MVA of load.[34] However, this is consistent with the proposed

[34] Should the load increase within demand group such it exceeds 90MVA and therefore the requirement to be secure for a busbar outage becomes applicable it would typically require for the busbar in question to be sectionalised (e.g., install a bus section circuit breaker).

requirements (refer to the footnotes on the Demand Group table in the proposed Technical Rules).

Western Power has identified one substation where the footnote on the Demand Group table would apply. For Mason Road substation, given the number customer connections and the size of those connections, it would be appropriate to consider a fully compliant (i.e., N-1-1) configuration and this would represent an upgrade.

- For the Perth CBD, demand groups in the ≥90 MVA & <250 MVA range are only likely to occur on the 132 kV double circuit lines supplying Hay Street or Milligan Street in the case where there is a total loss of supply capacity (N-2 failure) within the other substation e.g. the combined Hay Street and Milligan Street load is supplied on the 132 kV circuits supplying Hay Street (for a loss of infeed at Milligan Street or vice-versa). In this case further fault outages, beyond the occurrence of a N-2 fault that led to the combined Hay St / Milligan St load to supplied via one set of infeeding 132 kV cables, are not considered credible. Hence, a demand group in this range is unlikely to occur in practice within the Perth CBD[35] under intact conditions.

- For the All Areas demand group, the N-1-1 criteria is effectively captured based on demand thresholds rather than an explicit sub-network. The changed approach introduces flexibly as the system needs change. The following areas represent a step-change in the requirement:
  - The 132 kV terminal stations in Perth metropolitan area are already part of the existing N-1-1 criteria requirements. However, it is noted that some existing terminal stations were designed prior to current planning practices and the introduction of the Technical Rules[36].
  - Large demand groups (>250 MVA but less than 400 MVA) supplied from existing 132 kV zone substations and from terminal substations outside of the Perth Metro area. This change is appropriate and required for future developments. The updated standards are critical to support the scale of future developments expected on the power system.

For these areas where the existing configuration does not align with the proposed requirements, the flexibility introduced through economic assessment provisions that allow for higher or lower standards to be planned for where economic, enabling the network to remain compliant (including where grandfathering provision remain) whilst providing an opportunity for strategic investments where this is prudent. As such, the increased standards are not expected to result in an immediate step-change in capital investment unless this is critically necessary.

Table 4-4: Comparison of proposed and existing transmission planning criteria requirements

Area	Loss of demand	Considered *credible contingency*	Mapping to current Technical Rules
Rural	<10 MVA	*zone substation transformer*	Same as N-0 criteria in clauses 2.5.2.1(a) and (b)
	≥10 MVA & <60 MVA	*zone substation transformer*	Same as N-1 criteria 2.5.2.2(d) for N-1 substations.
	<20 MVA	*transmission circuit*	Same as N-0 criteria in clauses 2.5.2.1(a) and (b)
	≥20 MVA & <90 MVA	*transmission circuit, generator circuit* or *reactive equipment*	Slightly lower standard than N-1 criteria in clause 2.5.2.2

35 Note that East Perth Terminal substation does not fall within the designed CBD boundary as it is located north-eastwards of the defined CBD boundary of Wellington Street and Hill Street.

36 Neerabup, Guilford and Northern Terminals are examples.

	≥90 MVA & <250 MVA	*transmission circuit*, *generator circuit*, *reactive equipment* or *busbar*	Same as existing N-1 criteria in clause 2.5.2.2 except that a busbar outage is considered a credible contingency event.
Urban	<60 MVA	*zone substation transformer*	Same as N-1 criteria in clause 2.5.2.2(d) for N-1 substations. Increase in security standard for NCR and 1% risk substations.[37]
	<90 MVA	*transmission circuit*, *generator circuit* or *reactive equipment*	Same as N-1 criteria in clause 2.5.2.2.
	≥90 MVA & <250 MVA	*transmission circuit*, *generator circuit*, *reactive equipment* or *busbar*	Same as existing N-1 criteria in clause 2.5.2.2 except that a busbar outage is considered a credible contingency event.
Perth CBD	<60 MVA	*zone substation transformer*	Same as clause 2.5.3(b).
	<90 MVA	*transmission circuit*, *generator circuit* or *reactive equipment*	Same as clause 2.5.3(b).
	≥90 MVA & <250 MVA	*transmission circuit*, *generator circuit*, *reactive equipment* or *busbar*	Same as clause 2.5.3(b) except that a busbar outage is considered a credible contingency event.
All areas	≥250 MVA	*transmission circuit*, *generator circuit*, *reactive equipment* or *busbar*	Similar to clause 2.5.2.3 except that the threshold is now based on demand.

4.2 Definition of credible contingency

Credible contingencies are used in electricity network planning to define the set of circumstances that are reasonably foreseeable and should be planned for. The same terms are used in operational timeframes to define circumstances when the operator should reasonably be able to manage the system within acceptable, pre-defined limits. These circumstances can be distinguished from emergency operating states, where unforeseeable (or uncontrollable) events must be handled.

Credible contingencies applicable to the SWIS are defined in the WEM Rules and the Technical Rules. The current definition used in the Technical Rules are outlined in Table 4-5 below. The term 'Credible Contingency Event', is used throughout the Technical Rules, including in clause 2.5.2.3 (N-1-1 Criterion) and clause 2.5.8 (Maximum Fault Currents) within the transmission and distribution system planning criteria (section 2.5).

Table 4-5: Credible contingency definitions

Term	Definition
contingency event	An event affecting the power system which the Network Service Provider expects would be likely to involve the failure or removal from operational service of a generating unit or transmission/distribution element.
credible contingency event	A single contingency event of one of the following types:

[37] Although noted as an increase in security of NCR and 1% risk substations, given that in many cases the existing NCR requirements cannot be implemented in practice e.g., use of RRST, such substations are already supposed to be operated to N-1 standard. Hence, in such cases the proposed approach simply re-codifies the requirement that effectively exists currently, and as such does not lead to an increase in security design requirements.

	a. for voltages at or below 66kV, a three phase to earth fault cleared by disconnection of the faulted component, with the fastest main protection scheme out of service; b. for voltages above 66kV: i. a two-phase to earth fault cleared by disconnection of the faulted component, with the fastest main protection scheme out of service; or ii. a three-phase to earth fault cleared by disconnection of the faulted component, with the fastest main protection scheme out of service. This criterion is to be applied only to transmission elements where the Network Service Provider can demonstrate that the design type, environmental conditions, historic performance or operational parameters results in a material increase in the likelihood of a three-phase to earth fault occurring. c. a single-phase to earth fault cleared by the disconnection of the faulted component, with the fastest main protection scheme out of service; d. a single-phase to earth fault cleared after unsuccessful high-speed single-phase auto-reclosure onto a persistent fault; e. a single-phase to earth small zone fault or a single-phase to earth fault followed by a circuit breaker failure, in either case cleared by the operation of the fastest available protection scheme; or f. a sudden disconnection of a system component, e.g. a transmission line or a generation unit.

4.2.1 Current issue

Credible contingencies are well understood as a concept and there is agreement on how these should be planned for and managed in operational timeframes. However, several points of clarification were raised through the Technical Rules review. These included:

- Incorrect labelling of definitions – the current definition for credible contingency events is a list of faults with exception of the final item in the list, which is a disconnection. None of items listed is a contingency.[38]
- Potential confusion as to the treatment of particular plant when the timeframe under which credible contingencies can occur is considered.

  Contingencies within an operating timeframe may differ from those that can reasonably (and economically) be considered and catered for in a planning timeframe. That is, the contingency that is "credible" may necessarily differ across the time frames. In the planning timeframe, a lack of definition either exposes the operator to significant risk or is very costly if the range of credible contingencies that might arise in the operational timeframe are planned for. An example where this difference plays out is secondary systems. These systems need to be appropriately considered as credible continencies and more holistically where there is a risk of cascading effects due to outages or faults in these systems. Western Power has experienced difficulty in obtaining permission to take protection elements and other secondary systems out of service for maintenance due to the application of an expanded contingency definitions during the outage. This scenario may not have been considered in the design and specification of the secondary systems.
- Lack of clarity on the treatment of specific circumstances as contingencies, for example:
  - Loss of an entire busbar or bus section being classed as a credible contingency event and therefore the need for this to be considered from network planning, operations and outage

38 A contingency is a future event or circumstance which is possible but cannot be predicted with certainty.

- scheduling purposes. A related concern is whether the decision about what is credible takes into account the probability of the contingency or the consequence of the contingency if it occurred.
  - That the scope of power system elements that need to be considered is unclear when applying the N-1-1 criteria.
  - Whether contingencies are limited to single events or if they also contemplate multiples events. If the definition is narrowly considered, the risks posed by building multiple circuits in the one easement are not captured.[39]

Additionally, during the Technical Rules review, the operating states and contingency events outlined in the WEM Rules have been updated (note operating states are discussed further in section 9.5 of this submission). The changes include:

- Moving to an operating state framework that defines a satisfactory operating state and a secure operating state and an expectation of restoring the system to a secure state as soon as possible and within a time frame defined in the power system security principles.
- Adopting a secure operating state definition that requires the system to be able to sustain a credible single contingency events and return to in a satisfactory operating state following power system security principles. The definition of credible contingency event is an important aspect of the framework as are the power system security principles.
- Introducing a requirement that to the extent practicable, the SWIS should be operating such that it is in a reliable operating state.
- Introducing definition for credible contingency event and a reclassification framework allowing AEMO to decide when to treat non-credible events as credible.

While there is a benefit in aligning the framework for operating states and contingency events defined in the WEM Rules and Technical Rules, there is a risk that the Technical Rules and WEM Rules will become duplicative or become misaligned over time. Western Power also considers a further level of specificity is possible within the Technical Rules because the main function of the definitions is to drive outcomes in planning timeframes. Nevertheless, the two regulations should align to the extent practicable.

In other jurisdictions, the size or impact of the contingency is considered when deciding whether a particular contingency needs to be considered when planning and operating the transmission network. This approach is used in the Middle East and the UK, where the size of the demand group or generation impacted by an event is considered as well as the definition of the event or contingency. This approach allows, for example, a contingency that removes a bus section from service to be considered if there is a sufficiently large amount of load or generation impacted by the contingency. The advantage of this approach is that it clarifies which contingencies need to be consider in planning and operating the network as well as helping to prioritise what is reasonable given the relative impacts.

4.2.2 Solution options & preferred solution

In developing options to address the issues associated with the existing credible contingency definition, Western Power considered the proposed changes to the transmission system planning criteria discussed in section 4.1 of this submission. Included in those proposed changes are a more clearly defined set of outage and contingencies that should be considered credible within a planning timeframe.

[39] This network arrangement can present operability issues, for example, if during extreme weather conditions, the loss of multiple circuits is reclassified as a credible contingency event. Securing the network for that reclassified contingency can be difficult if the network was not designed to provide the necessary levels of redundancy.

Options considered include:

a) Revising the credible contingency definition in planning timeframes to align with an updated definition used in operational timeframe (and broad principles of WEM Rules outcomes).

b) Updating the credible contingency definition in planning timeframes only.

c) Clarifying the terminology used in definitions and adopting clearly specified credible contingency circumstances in the updated transmission planning criteria.

d) No change.

Of the considered options, option c) is recommended. The term credible contingency is used in several areas through the Technical Rules, including for distribution system requirements where the WEM Rule definitions may not be directly applicable. The approach drives appropriate alignment between the definitions in the WEM Rules and Technical Rules but recognises the benefit of more explicit contingency definitions be specified in the Technical Rules as this allow better clarity and transparency regarding the transmission planning criteria.

Alignment with the WEM Rules was strongly considered. However, the range of circumstances that can be considered credible in operating timeframes is necessarily different from those that should prudently be considered within planning timeframes. The proposed changes for the transmission system planning criteria adequately cover the range of credible faults and outages that are currently being planned for and provide a more transparent solution.

4.3 Use of alternative plant ratings within planning timescales

Plant ratings are the limits given by manufacturers to equipment used in the power system. Long term ratings are those ratings that can be maintained under most circumstances. Equipment can be operated at the long term ratings without risk of the asset life being shortened or other adverse effects occurring.

Alternative and short term ratings are typically greater than long term ratings for the same equipment. These ratings consider conditions such as temperature or the time period over which the equipment can safely be run at the specified rating. Alternative ratings in a planning context can include short-term permissible thermal ratings for overhead lines or substation transformers for minutes or potentially hours to facilitate load transfers during outage conditions, or alternative ratings for adoption within the planning timescales beyond typical summer, spring/autumn, winter ratings commonly used. Equipment is often able to run safely at alternative or short term ratings for a period of time. However, operation at these limits for longer period risks stressing the equipment to the point of failure.

The difference between long term and alternative or short term ratings provides operators of the power system a degree of flexibility in the way they manage the system. Knowledge of these ratings enables them to safely demand more from equipment when needed to provide for short term requirements or in an emergency.

The adoption of alternative ratings by planners of the system can lead to deferral of upgrades. For example, the planner may determine that is appropriate to use short term ratings in some scenarios rather than applying the stricter long term rating. Often an additional margin is added to ratings to account for uncertainties that might arise in operational timeframes. It is important when choosing ratings in planning timeframes that the network planner preserves sufficient margin to cater for uncertainty. This is particularly important if the planner is considering adopting short term ratings in order to defer investment. Failure to preserve sufficient margin risk under-investment resulting in operational difficulties particularly under unexpected conditions.

4.3.1 Current issue

The Technical Rules do not reference or make explicit allowance for short-term or other plant and equipment ratings in a planning context. As such, it is not clear how these alternative ratings may be adopted to meet the transmission and distribution planning criteria. Nevertheless, the use of long term and short term emergency ratings for underground cables, in addition to normal cyclical ratings, is detailed in the Western Power Distribution Planning Guidelines including use in potentially deferring projects due economic inefficiencies, financial or deliverability constraints.

There may be advantages in clarifying in the Technical Rules how and when alternative ratings may be used when planning the transmission and distribution system. Benefits of using these ratings in planning timeframes include:

- providing additional flexibility in relation to the development of future network capital investments,
- optimisation across a portfolio of projects, and
- potentially allowing some projects to be deferred.

However, as highlighted above, a balance needs to be stuck between planning allowance and the need to leave operational and control system engineers with some “headroom” to operate the system.

Additionally, the application of alternative and short-term plant and equipment ratings may require investment in equipment to measure ambient conditions in real time. Up to date information on the condition of assets is also required to facilitate the specification of appropriate equipment ratings. To implement alternative ratings in an operational timeframe it may also be necessary to adjust protection settings. The cost of the measures necessary to facilitate the use of alternative ratings should be considered carefully and may limit the scope for applying alternative ratings to just those instances where doing so will avoid material network augmentations or upgrades.

4.3.2 Solution options & preferred solution

Western Power considered the following options that would address the above issue:

a) Update the transmission planning criteria to explicitly allow the use of alternative or short-term ratings when determining compliance with planning criteria, including detailing specific requirements for individual plant types and voltage levels.

b) Update the transmission planning criteria to explicitly allow the use of alternative or short-term ratings when determining compliance with planning criteria, but only include high level description.

a) No change.

Of the considered options, option b) is preferred. The revised transmission planning criteria includes a general requirement that clarifies the arrangements for when short-term and other alternative plant are used. The updated drafting requires the Network Service Provider to maintain up to date, functional and deliverable outcomes in operational timescales when using these ratings.

The preferred option recognises that there may be limited cases where such approaches can be useful applied, but also recognises that underlying asset condition data may not be perfect in all instances and also that some flexibility in plant capacity is needed in operational timeframes and during contingencies i.e., cannot be used in planning timescales.

Option a) is not recommended at this stage. Detailing requirements for specific plant types, demand groups or voltage levels for the transmission system is a potentially resource intensive exercise. Western Power considers developing an approach as needs arise is appropriate in the first instance following this change.

Option c) is also not recommended. Remaining silent on the use of alternative ratings within the transmission system planning criteria risks leaving consideration of this flexibility and subsequently the use of the flexibility unclear. There is therefore a risk that planning and operational outcomes are less coordinated than they would be with an explicit reference and link.

4.4 Perth CBD planning criterion & definition

The Technical Rules sets out a defined planning criterion that applies to "sub-networks of the transmission system that transfer power to the Perth CBD and zone substations …". The requirements are detailed in clauses 2.5.3 and these provisions are complimented by requirements in clause 2.5.5.2 (distribution feeders). Perth CBD is defined in the Glossary with reference to a geographic area within the City of Perth and the zone substations suppling that area (Table 4-6).

Table 4-6: Current Technical Rules definition for Perth CBD

Term	Current definition
Perth CBD	The geographical area in the City of Perth bound by Hill Street (East), Havelock Street (West), Wellington Street (North) and Riverside Drive and Kings Park Road (South) and supplied (exclusively or in part) from the following *zone substation*s: Hay Street, Milligan Street, Wellington Street, Cook Street and Forrest Avenue[(1)]. [(1)] Subject to a periodic review

4.4.1 Current issue

During the review process Western Power considered the role of the Perth CBD criterion and whether it should be updated. Consideration was given to the following:

- Whether the security requirement should be retained for the Perth CBD.
- The geographic boundary as outlined in the Glossary was developed based on the location of government and other high importance loads. However, since then new developments have arisen (e.g., Elizabeth Quay, Metro Arena area) as well developments just outside and on the fringes the defined boundary area. Additionally, there is significant interconnection at distribution system level and between substations both within and outside the CBD. Collectively, this demonstrates the difficulty in drawing a geographic boundary that fully captures issues associated with supply to, and security of customers within the Perth CBD.
- Forrest Avenue zone substation has been decommissioned.

4.4.2 Solution options & preferred solution

Western Power considered the following options that would address the above issue:

a) Update the current defined geographic boundary Perth CBD area to account for new load area developments and update substation references.

b) Remove the geographic boundary element from the Perth CBD definition and leave the definition based on reference to particular substations (updated if necessary). Incorporate the current Perth CBD requirements into a specific demand group within the proposed transmission system planning criteria

c) Remove references to zone substation supplying load from the Perth CBD definition and incorporate the Perth CBD requirements into a specific demand group within the proposed transmission system planning criteria.

d) Remove references to the Perth CBD boundary from the transmission system planning criteria and rely on the demand groups within the proposed criteria to provide for suitable requirements based on the load for that area. Update the Perth CBD definition to enable references in the Technical Rules function appropriately.

e) No change.

Of the considered options, option c) is preferred. There was broad agreement throughout Western Power and representatives at AEMO and Energy Policy WA that were consulted during the development of the proposed Technical Rules that there remains a need for a higher planning security standard for the Perth CBD area, which is something that also applies in other jurisdictions.

Option c) will allow a defined CBD area to be maintained for the purpose of the planning standard. The change in definition to refer only to a geographic boundary allows for the more efficient supply of that area and removes the need to make upgrades for a wider and less critical areas supplied by the named substations. Reference to the Perth CBD area and particular requirements have been incorporated in the proposed transmission planning criteria outlined in section 4.1 of this submission. In the proposed changes, the Perth CBD is called out in the demand group table and given an N-2 criterion consistent with current arrangements.

Option a) was discounted as it is considered a temporary fix and would need to be further adjusted if and when new load developed close to the revised new boundary.

Options a), b) and e) all retain references to substations. As seen following the retirement of the Forrest Avenue substation, associating definitions with fixed substations risks the definition becoming out of date. Several of the substations listed in the current definition will need to be upgraded or modified in the next 10 to 15 years. Further, labelling substations provides a degree of inflexibility. As the network changes over time, the loads supplied by the substations can change and leading to coverage becoming unclear.

Option d) is conceptually appealing, particularly as the proposed transmission system planning criteria naturally adapts as demand moves across the power system. Under this option, if load were to move away from the CBD, the requirement to maintain the highest levels of security would automatically fall away leading to reduced network expenditure in the longer run. However, this would be a fundamental change to the supply reliability provided for the Perth CBD, which would be inconsistent with other jurisdictions.

4.5 Distribution system planning criteria

Like the current transmission system planning criteria, the planning criteria for the distribution system is deterministic in nature. It applies specified redundancy levels for substations or network types and is largely based on geographic boundaries. Areas that have historically experience higher load typically have higher redundancy requirements.

The main elements of the current distribution planning criteria detailed in sections 2.5.5.1 to 2.5.6.2 of the Technical Rules are presented in Table 4-7.

The distribution system planning criteria is supported by the Distribution Network Planning Guideline. This guideline provides comprehensive guidance on the detailed application of the distribution planning criteria considering the various factors that can change across the different parts of the distribution network.

Table 4-7: Summary of existing distribution planning criteria

Criteria	Description
N-0	Loss of supply occurs following a fault outage until the failed equipment has been repaired or replaced. This general criterion applies to the whole distribution system.
HV feeders in the Perth CBD	Distribution feeders in the Perth CBD must be designed such that during an outage, supply can be restored using remote controlled switching.
HV urban feeders (outside the Perth CBD)	Distribution feeders must be designed such that during an outage, supply can be restored using manual switching. Applies outside of the designated Perth CBD boundary.
HV radial feeders (within Perth metro area)	Distribution feeders should be designed to limit the number of customers on a switchable feeder section to 860 if the feeder section cannot be energised through a backup interconnection. Applies within the Perth Metro area.
HV rural feeders	Distribution feeders are normally designed without interconnection unless such interconnection is technical and economically feasible.
LV feeders	Designed to the N-0 criteria unless interconnection is technically and economically feasible. For underground residential subdivisions, a switching point must be provided for every 16 connection points.

4.5.1 Current issue

Given the proposed changes to the transmission system planning criteria, where a more structured approach based around demand groups is proposed, there is an opportunity to similarly revise the distribution planning criteria.

A variety of more minor issues have been identified with the current distribution planning criteria. Several of these are addressed in the remainder of this section.

In addition, the current distribution requirements are largely fragmented and detailed within individual clauses, with some requirements detailed in the Distribution Planning Guideline.

4.5.2 Solution options & preferred solution

Western Power considered the following options that would address the above issue:

a) Update and amend existing clauses related to the HV and LV distribution system to address current know issues and limitations (as outlined in sections 4.6 and 4.7 in this report).

b) Provide a comprehensive update of the LV and HV distribution system planning criteria to introduce a structured approach more in keeping with the revised transmission planning criteria and with the planning security standards that apply in other jurisdictions.

c) No change.

Western Power proposes changes consistent with option a). This option addresses the immediate issues related to the distribution system planning criteria.

Option b) was considered in-depth and is expected to be preferred in the longer term as it will enable more flexible planning of the system. However, Western Power considers taking a staged approach to reform of the system planning criteria appropriate given the type of changes being considered. The staged reform of transmission first and then distribution system planning at a later date will make better use of scarce planning resources and enables learnings from the adoption of reforms to transmission system planning to be feed into future distribution system planning changes.

As part of the Technical Rules review, Western Power developed draft demand groups for distribution that aligned with those proposed for the transmission planning criteria. Western Power considered a restructure based on the demand size and security requirements (similar to the transmission planning criteria). However, Western Power also considered an approach structured around voltage levels and urban and rural area definitions. This second option is likely to be more appropriate as it allows the key difference that arise between the longer rural and short metropolitan distribution feeders to be considered.

If adopted, these changes would align with the format adopted in other jurisdictions, e.g., Essential Energy, where distribution network planning and design requirements are structured based on regional or area classification with population references.

A staged approach to reform will also allow Western Power to consider and revisit the balance of prescription across the Technical Rules and in the Distribution Network Planning Guidelines.

In addition to implementing changes consistent with option a), structural changes are proposed for the distribution system planning criteria that separate the transmission and distribution planning criteria. This includes giving some existing criteria a lower heading level within the Technical Rules, so all clauses related to the distribution system planning criteria are contained within a single section.

4.6 Distribution feeders in the Perth CBD

Clause 2.5.5.2 of the Technical Rules sets out the requirements for distribution feeders in the Perth CBD. It states:

> *Distribution feeders in the Perth CBD must be designed so that in the event of an unplanned loss of supply due to the failure of equipment on a high voltage distribution system, the Network Service Provider can use remotely controlled switching to restore supply to those sections of the distribution feeder not directly affected by the fault.*

Redundancy in the feeders in the Perth CBD is required because these feeders supply critical load. Consistent with the status of this load, remote control is used to ensure the timely operation and control of switching needed to maintain supply to this area.

4.6.1 Current issue

The current wording places remote control switching requirements only on feeders *in* the Perth CBD and is not clear on coverage for sections of feeders that sit outside of the defined Perth CBD boundary but originate from within the Perth CBD boundary. A strict interpretation of the drafting may result in inefficient expenditure relative the desired objective of securing load within the Perth CBD.

For example, if half of a feeder lies within the Perth CBD and half outside, a narrow interpretation would result in only half of that feeder being considered for remote switching (the part that falls within the Perth CBD). However, installations on the second half of the feeder (outside the Perth CBD), which still controls the whole feeder, may be a more efficient means of achieving the CBD requirements.

As discussed in section 4.4 of this submission, the definition for Perth CBD is problematic and requires revision. Even with the proposed revision clause 2.5.5 of the Technical Rules should be clarified so that drafting better aligns with the likely objective of the clause.

4.6.2 Solution options & preferred solution

Western Power considered the following options that would address the above issue:

a) Update drafting of clause 2.5.5.5 of the Technical Rules to clarify requirements so that the critical load is treated as such.

b) No change.

Option a) is preferred. Proposed drafting aligns with the intended purpose of the clause and avoids boundaries that are arbitrary from an electrical systems perspective. The preferred solution clarifies the requirement to make investments to apply the requirements to load supply by zone substations in the Perth CBD as well as feeders within the Perth CBD. This also aligns with updates to the definition of Perth CBD discussed in section 4.4 of this submission to ensure the combined changes maintain the existing planning standards for this area.

4.7 Distribution visibility

Distributed energy resources, including electric vehicles, household battery storage and solar rooftop PV, are changing the way the distribution system is used. Historically, visibility was required at transmission levels and introduced by exception at distribution voltages. However, improved visibility over the distribution system is needed to understand and, where appropriate, manage these changed flows. Improved visibility also allows adoption of less conservative limits improving the ability to host renewable generation connected to the distribution network.

Visibility over power system flows can come from a range of data points across the system. However, transformers are a critical part of the distribution system infrastructure and it's critical to understand the power flows over these assets so that these assets are not overloaded and unable to perform their functions optimally. Measurements taken at distribution transformer locations also help the Network Service Provider better understand and estimate the power flows across the upstream and downstream networks and the voltage performance.

Clause 2.6(f) of the Technical Rules relates to the provision of load monitoring equipment on distribution transformers. The clauses states:

> *"Distribution transformers rated at 300 kVA or above must be fitted with load monitoring equipment. This must provide a local indication of actual and peak load and must be capable of being modified in the future to enable remote monitoring of the transformer load".*

Load monitoring equipment collects a range of data depending on specifications and may facilitate local and remote readings. The key parameters needed to understand power flows and power quality at a distribution level include:

- Actual and peak load
- Signed (i.e., positive or negative) active power (kW) and reactive power (kvar), voltage and current.

Remote monitoring enables timely collection and analysis of data leading to faster response times where operational controls are needed in real time. Remote monitoring provides more accurate assessment of the state of the distribution network, which assists Western Power to operate assets closer to their rated capacity, which in turn improves the ability to host distributed energy resources such as roof top PV systems.

4.7.1 Current issue

The current wording of clause 2.6(f) of the Technical Rules limits Western Power's ability to install *remote* load monitoring equipment on distribution transformers during initial construction and development by requiring only that the transformer has the capability to be modified in the future. While it is possible to retrofit remote load monitoring equipment to larger distribution transformers and Western Power has done this in the past, the practical issues associated with fitting monitoring to already installed transformers often make this option less attractive and therefore less preferred.

A more efficient and effective approach that achieves greater visibility over time is to enable new transformers to be fitted with remote load monitoring equipment as they are installed. This approach provides the monitoring at a much lower cost as it avoids the expense of a brownfield retrofit.

Going forward Western Power requires greater visibility and remote monitoring of the distribution network to effectively manage the power system, maximise the ability to connect DER and optimise expenditure. In particular, greater visibility at the distribution level will allow Western Power to:

- more readily identify and manage emerging system issues,
- more confidently identify available network capability reducing the need to limit renewable generation or distributed energy resources, and
- understand where and what type of network management or control options are required to achieve the greatest benefit more quickly.

This view aligns with that of AEMO and Energy Networks Australia, who identified defining enhanced network visibility as a key capability for any future Distribution System Operator and Distribution Market Operator role.[40]

Other jurisdictions have found direct benefits in installing improved monitoring and remote control on low voltage transformers. Box 4-4 provides case studies from Scottish and Southern Energy Networks in the UK and SA Power Networks in South Australia.

In the UK, the Distribution Network Operators have a separate budget for conducting innovative trials for new technologies, processes and commercial arrangements. This has helped roll-out active network management and intelligent voltage control across the distribution network, resulting in savings to customers and faster connections. The innovative projects are reported on through the Open Networks Portal, managed by Energy Networks Association (UK), to enable shared learnings[41].

Box 4-4: Case studies for installation of remote monitoring control on LV transformers

Scottish and Southern Energy Networks - Low Cost LV Substation Monitoring

An LV substation monitoring project undertaken by Scottish and Southern Energy Networks in the UK involved a trialling low-cost retrofit monitoring solutions for LV feeder pillars. The £1.1 million project enabled data from the equipment to be transmitted via cellular network to a data portal.

The data collected through the project provided much greater visibility of the LV network and valuable details on electric vehicle hotspots and network imbalances.

The study has helped Scottish and Southern Energy Networks understand where DER, including electric vehicles, is growing and the level of reinforcement required. Of note, the data can be used to manage and control the network more efficiently and consequently defer augmentations.

40 AEMO and Energy Networks Australia, Interim Report: Required Capabilities and Recommended Actions, report for the Open Energy Network Project, July 2019. Available here.

41 Refer to: https://www.energynetworks.org/creating-tomorrows-networks/open-networks/

SA Power Networks – LV Transformer Monitoring[42]

SA Power Network's LV monitoring program involves installing and commissioning permeant remote monitoring at a sample set of approximately 1,300 multi-customer LV distribution transformers in the metropolitan area to improve capacity and planning in the LV network.

In the longer term, the permanent monitoring sites established through this program will enable the current practice of undertaking around 500 transformer load surveys each year using temporary loggers to be phased out, giving a permanent reduction in operating costs. As a consequence, SA Power Network estimates over the 15-year life of the transformer monitors the program has positive net present value under all sensitivity cases considered in the business case.

The Australian Energy Regulator approved $5.2 million for this program (of which $1.3 million is operating expenditure) in its final decision.[43]

4.7.2 Solution options & preferred solution

Western Power considered the following options that would address this issue:

a) Modify clause 2.6(f) of the Technical Rules to require all new distribution transformers >300 kVA to be capable of remote load monitoring. Continue to allow existing transformers >300 kVA to be retrofit, where reasonable.

b) Modify clause 2.6(f) of the Technical Rules to require all new distribution transformers >300 kVA to be capable of remote load monitoring. Allow all existing transformers to be retrofit, where reasonable, and provide guidance examples in a drafting note.

c) Keep existing clause 2.6(f) wording but detail the acceptable conditions under which the modifications should take place and the economic and technical arguments that would support this. This detail may be outside of the Technical Rules i.e., in the Distribution Network Planning Guideline or another procedural document.

d) No change.

Of the considered options, option b) is recommended. This is the most efficient option to provide the necessary increase in visibility to manage the increasing level of distributed energy resources being connected to the distribution network.

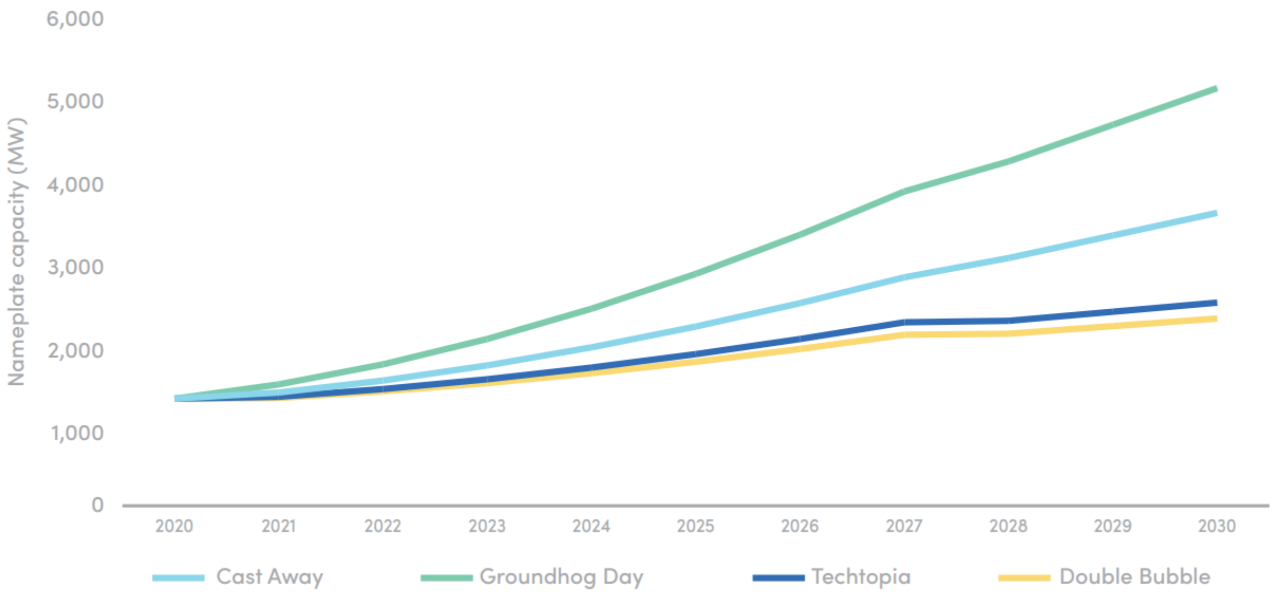
The need for improved visibility is evident from the projected increase in distributed energy resources, mainly rooftop PV systems assumed in the 2020 Whole of System Plan.[44] The four scenarios in the Whole of System Plan project continued growth in the capacity of installed roof top PV systems connected to the SWIS. For example, the Groundhog Day scenario assumes rooftop PV capacity increases from 1,291 MW in 2020 to 5,037 MW by 2030 (Figure 4-1).

[42] SA Power Networks, LV transformer monitoring business case (supporting document 5.15), 2020-25 Revised Regulatory Proposal, 27 November 2019.

[43] Australian Energy Regulator, *Attachment 5: Capital expenditure, Final decision SA Power Networks 2020-25*, June 2020, p. 5-40. Available here.

[44] Energy Transformation Taskforce, *Whole of System Plan 2020*, August 2020. Available at: https://www.wa.gov.au/government/document-collections/whole-of-system-plan

Figure 4-1: Cumulative rooftop PV capacity 2020 to 2030



Source: Energy Transformation Taskforce, *Whole of System Plan 2020*, August 2020, Figure 4.13, p. 59.

The requirements for small generating systems are specified in sections 3.6, 3.7 and 3.8 of the proposed Technical Rules. As discussed in section 6.4.2 of this submission, the revised User requirements place an obligation on all generating systems to be able to operate to an export limit set by the Network Service Provider. This change is necessary to provide Western Power with the ability to impose export limits where required to ensure the capability of the distribution system is not exceeded.

The improved visibility provided by option b) will help Western Power set appropriate export limits that maximise the opportunity for embedded generators to export power while managing the security of the distribution system.

Option b) is a prudent approach to providing increase visibility. The option allows for the installation of remote load monitoring on transformers >300 kVA when these are installed (or replaced) – when it is most cost effective to install equipment.

For other transformers, the option does not mandate that remote monitoring is enabled, instead it provides the discretion for Western Power to do so where warranted. This will allow Western Power to only activate remote monitoring on new transformers where there is an assessed need to do so. In situations where there is insufficient need for remote monitoring (i.e., there is forecast to be very low penetration of embedded generation) Western Power can avoid activating remote monitoring at the time of commissioning thereby avoiding the cost of providing the communications facility to transmit the monitored quantities back to the Western Power control centre.

The proposed option will allow Western Power to add remote monitoring when new transformers are commissioned in areas of the network where there is a strong need for improved visibility. These are likely to be areas of the network project to experience growth in distributed energy resources.

4.8 Remote monitoring and control of high voltage switchgear

Clause 2.6.6(d) of the current Technical Rules permits the Network Service Provider to remotely monitor and control high voltage switchgear where this can be shown to be the most cost efficient approach to meeting the reliability targets set out in the access arrangement.

4.8.1 Current issue

The drafting of clause 2.6.6(d) of the current Technical Rules limits the benefits that can be considered when the Western Power is deciding to remotely monitor and control high voltage switchgear because it only recognises those benefit inherent in the achievement of reliability targets that will be realised within the period of the access arrangement (reliability targets do not exist beyond any one access period). In practice, the benefits may extend beyond those benefits inherent in achieving the reliability targets, and the benefits may extend beyond the five year period of an access arrangement.

4.8.2 Solution options & preferred solution

Western Power considered the following options that would address the above issue:

a) Modify the drafting to permit a boarder range of customer reliability benefits to be considered and to remove the reference to the access arrangement to ensure benefits that extend beyond any one access arrangement are appropriately valued in the investment decision.

b) No change.

Option a) is preferred. This solution retains the intention of the existing drafting, which is to allow investment in remote monitoring and control of high voltage switchgear where this is shown to be the most cost efficient approach. However, it appropriately allows for recognition of all customer reliability benefits associated with the investment to be valued, including across the life of the assets. The updated drafting also aligns with changes that will be needed to support a future Distribution System Operator role.

5. Transmission and distribution system protection

The transmission and distribution system protection requirements that apply to Western Power's networks are contained in section 2.9 of the Technical Rules.

The structure of these sections of the Technical Rules is illustrated in the following diagram.

2.9 – Transmission and Distribution System Protection

2.9 Transmission & Distribution System Protection

- 2.9.1 – General Requirements
- 2.9.2 – Duplication of Protection
- 2.9.3 – Availability of Protection
- 2.9.4 – Maximum Total Fault Clearance Times
- 2.9.5 – Critical Fault Clearance Times
- 2.9.6 – Protection Sensitivity
- 2.9.7/8 – Trip Supply / Circuit Requirements
- 2.9.9 – Protection Flagging & Indications

The limitations, issues and proposed solution to address issues that have been identified through the Technical Rules review process are discussed in the sub-sections that follow.

5.1 Clarity on duplication of protection requirements

The role of protection schemes in a power system is to keep the power system stable by rapidly isolating all components that are under fault, but also ensure that the sections of the network that have no fault will continue to operate (protection discrimination). Protection systems should also remain unaffected by conditions external to the protected zone (protection stability). The reliable operation of these schemes is therefore critical for power system stability and security.

Due to the critical role protection schemes play, it is common for these schemes to be duplicated to provide independent schemes which provide reliable clearing of a fault even if one of the primary protection scheme fails. For duplication to provide a robust protection system, the two schemes must be capable of operating fully independently (i.e., no shared communications or power supply), and they should not be vulnerable to the same equipment failures.

Power systems rules commonly require network operators to install two fully independent protection schemes of different principles or manufactured by different organisations, if these use the same principles, to minimise the risk that both protection schemes fail to operate as a consequence of either the principle failing to detect the fault or a failure of the protection relay.

5.1.1 Issue

Several clauses in the Technical Rules require "two fully independent protection schemes of differing principles[45]" to be implemented. However, there are situations when this may not represent the best solution and having two protection systems with the same operating principle would be preferred. For example, where the speed of the protection system is critical, and the use of two different methods results in inadequate primary protection because the second method is not sufficiently quick.

[45] In this context, the principle refers to the way that the protection system detects or measures the faults.

The Glossary defines the term 'two fully independent protection schemes of differing principles' and makes it clear that the same method of operation for both schemes is permitted if the two schemes have "been designed and manufactured by different organisations" (Table 5-1). However, there is currently no reference to this exception within the clause drafting. As such, it is only indirectly discoverable that this exception applies and the requirement around when to use schemes of differing principles may be ambiguous.

Table 5-1: Relevant protection scheme definition in the Technical Rules

Term	Current definition
two fully independent protection schemes of differing principle	*Protection schemes* having differing principles of operation and which, in combination, provide dependable detection of faults on the protected *primary equipment* and operate within a specified time, despite any single failure to operate of the *secondary equipment*. To achieve this, complete secondary *equipment* redundancy is required, including *current transformer* and *voltage transformer* secondaries, auxiliary supplies, signalling systems, cabling, wiring, and circuit breaker trip coils. Auxiliary supplies include DC supplies for *protection* purposes. Therefore, to satisfy the redundancy requirements, each *protection scheme* would need to have its own independent battery and battery charger system supplying all that *protection scheme*'s trip functions. In addition, the relays of each *protection scheme* must be grouped in separate physical locations (which need not be in different panels). Furthermore, the two *protection schemes* must either use different methods of operation or, alternatively, have been designed and manufactured by different organisations.

5.1.2 Solution Options

Western Power considered the following options that would address this issue:

a) Amend clauses that refer to "*two fully independent protection schemes of differing principle*" to remove "of differing principle". Update the Glossary definition accordingly.

a) Amend clauses that refer to "*two fully independent protection schemes of differing principle"* to say, "two fully independent protection schemes of differing principle or have been designed and manufactured by different organisations."

b) No change.

Western Power considers both options achieve the same aim. However, option a) is slighter simpler to implement as the term "two fully independent protection schemes of differing principle" is defined in the Glossary and used in a number of clauses of the Technical Rules. As such, Western Power recommends changes consistent with option a) be implement revisions to six clauses in the revised Technical Rules[46].

5.2 Duplication of protection where fuses are used

Protection systems are duplicated in a power system because of the critical role they play in avoiding situations that would overwise pose a significant risk to human and system safety. The duplication requirement acknowledges that technology and equipment involved is typically not fail safe. Should the primary protection system fail for any reason, a secondary system is available that preforms the same protective function.

[46] Clauses 2.9.2(a)(1), 2.9.2(a)(2), 2.9.2(b)(2), 3.5.2(c), 3.5.2(d), 3.5.3.6.

However, some protection equipment is designed to be fail-safe. That is, the design inherently responds in a way that will cause minimum or no harm to other equipment, to the environment or to people. Fail-safe in this context does not mean that failure is impossible or improbable, but rather that the system's design prevents or mitigate unsafe consequences of the system's failure.

5.2.1 Issue

Clause 2.9.2(b)(1) of the Technical Rules requires that "primary equipment forming part of the distribution system must be protected by two independent protection systems". Fuses, which form part of the distribution protection systems, are considered under Western Power's distribution design policy to be inherently failsafe. Consistent with this view, there is not typically a requirement to duplicate this part of the protection systems in other jurisdictions, such as Great Britain.

Western Power has historically exercised judgement in interpreting the Technical Rules and not installed duplicate protection systems on parts of the high voltage distribution network that are protected by fuses. Installing additional fuses to fulfil the requirements for a second protection system would incur unnecessary equipment duplication and be uneconomic.

5.2.2 Solution options & preferred solution

Western Power considered the following options that would address this issue:

a) Amend the existing clause wording to make clear where Western Power design policies apply and where deviation from the duplicate protection system requirement is acceptable.

b) No change.

Western Power recommends option a) is implemented. This option reflects practice in other jurisdictions and avoids the situation where Western Power is in breach of the Technical Rules or otherwise required to incur additional uneconomic costs by installing duplicate protection systems where fuses are used in the distribution system.

The recommended drafting for clause 2.9.2(b)(1) makes clear that parts of the distribution systems protected by fuses do not need to meet the duplicate requirements.

5.3 Availability of protection systems

Similar to other equipment on the power system, protection systems (and schemes) need to be taken out of service from time to time for upgrades, maintenance and repair.

5.3.1 Issue

Clause 2.9.3(a) of the Technical Rules allows protection schemes to be taken out of service for up to 48 hours every 6 months without necessarily removing the protected primary equipment from service. However, there is no differentiation between unplanned and planned outages.

For unplanned outages, 48 hours is considered an acceptable time period to replace the majority of failed components. However, for planned outages, the complexity involved in undertaking full protection system replacements or significant upgrades can require an outage of a significantly longer duration. So long as there are no unreasonable risks to the power system from allowing an outage of protection schemes, enabling a longer period for planned protection system outages should support more efficient outcomes.

Further, under clauses 2.9.3(b) and 2.9.3(c) of the Technical Rules, the protected element must be removed from service (in addition to the protection scheme) unless instructed otherwise by AEMO in the case of transmission system protection, or in the case of distribution protection, the Network Service Provider assesses the distribution system elements must remain in services to maintain power system stability.

There are circumstances whereby protection needs to be taken out of service longer than 48 hours to facility critical maintenance work. In these circumstances, it may not be possible to take a primary plant outage. However, changes could be introduced that allow for a mechanism to assess the risk of the protection outage and have an appropriate approval process in place. This would ensure the risk of taking the protection out for longer than 48 hours while keeping primary plant in service is managed.

The allowed outage duration of 48 hours is limited to one period every 6 months. Western Power understands the purpose the 6 monthly limit is to put some bounds around taking multiple consecutive outages for the same equipment. This ensures customers that might otherwise be affected do not experience more or longer outages than needed. However, the 6-month limitation:

- can make scheduling of upgrades and maintenance difficult,
- is impractical as the 6-month period is difficult to track, and
- may be unnecessary where protection is duplicate and outages leaving one protection scheme in service are acceptable.

Further, the protection outages taken in alignment with the current Technical Rules are done to improve the conditions of assets and Western Power does not consider this limit should hinder the ability to make these improvements.

If the Technical Rules were updated to allow outages beyond 48 hours (subject to appropriate risk-assessment and approvals) the need to take multiple outages within a 6-month period is likely to reduce.

5.3.2 Solution options & preferred solution

Western Power considered the following options to address the above issue:

c) Amend clauses 2.9.3(a) to 2.9.3(c) of the Technical Rules to provide for an updated risk-based approach to allowing equipment outages where protection system outages are planned.

a) Remove the reference to 6 months in clause 2.9.3(a) of the Technical Rules.

b) Options a) & b).

c) No change.

Option c) is preferred. Removal of the six month limit on outages will enable appropriate and timely upgrade and maintenance of protection schemes and systems. The risks associated with outages of protected equipment can be managed through the updated clauses that require the Network Service Provider to conduct a risk-assessment and put in place risk-mitigation for equipment outages associated with planned protection system outages. The requirement to keep protected transmission equipment in service if required by AEMO is maintained. As outlined above, the changes are similar to the practice already adopted by Western Power for construction work activities where a detailed risk assessment and mitigation paper is routinely compiled before undertaking planned outages.

5.4 Application of maximum total fault clearance times for ‘new’ and ‘existing’ equipment

Maximum total fault clearance times are maximum allowed time in which a fault should be cleared. As outlined in the Glossary for the Technical Rules, this is the time from fault inception to the time of complete fault interruption by a circuit breaker or circuit breakers. The total fault clearance times take into consideration the time taken for both circuit breakers and protection equipment to operate.

The ability for equipment to meet maximum total fault clearance times depends on the nature of technology and when it was developed as well as the range of equipment that, together, dictate the clearance time.

Technology changes mean that newer equipment tends to operate significantly faster than equipment that was installed prior to the Technical Rules commencement (in 2007). However, as the total time achievable is limited by all equipment that together results in the clearance of a fault, the operating times of equipment involved in each system must be considered in setting an appropriate maximum total fault clearance time. For example, where a protection relay detects a fault and sends a signal to a circuit breaker to open, the time to clear a fault is the time to detect the fault (dictated by the relay logic process and response) plus the time it takes to open the circuit breaker (i.e., receive and respond to the signal). A very small amount of time is also included in the total times that reflects operation of communication equipment.

5.4.1 Issue

Clause 2.9.4 of the Technical Rules sets out the maximum applicable fault clearance times for zero impedance short circuits faults at different voltage levels across the SWIS. Two sets of applicable maximum clearance times are detailed in Tables 2.10 and 2.11 of the Technical Rules, those that apply to Existing Equipment and those that apply to New Equipment. With the times that apply for Existing Equipment are typically longer than those that apply for New Equipment.

As per sub-clause 2.9.4(i), the term “existing equipment” refers to equipment in service at the Rules commencement date, which for the current version is defined as 1 July 2007. Accordingly, equipment that forms part of protection systems that was installed prior to 1 July 2007 is only required to meet the Existing Equipment times.

Given there are multiple pieces of equipment that together comprise a protection system, in some instances, it is unclear exactly what equipment is being referred to and how the term “Existing Equipment” should be interpreted in practice.

There is also no differentiation between primary and secondary equipment with regards to “existing” or “new”. In practice, this lack of clarity creates confusion as to which definition applies when, for example, a partial replacement of protection relays and other secondary equipment is carried out, but related switchgear (primary equipment) is not upgraded.

5.4.2 Solution options & preferred solution

Western Power considered the following options to address the above issue:

a) Amend existing clause wording by removing column labels “Existing Equipment” from Tables 2.10 and 2.11 and adopt either the ‘New Equipment’ or the ‘Existing Equipment’ times for all equipment covered by the tables.

b) Clarify the definition of “existing equipment” under sub-clause 2.9.4(i) to refer to a defined ‘material changes’ such that the correct and appropriate maximum fault clearance times that apply under partial component upgrade conditions are clear.

c) No change to drafting of clause 2.9.4 but use the guideline introduced under clause 1.9.4 of the proposed Technical Rules to capture appropriate guidance.

Option c) is the preferred option. The guideline proposed under changes to clause 1.9.4 (discussed in section 2.6 of this submission) provides an efficient and flexible mechanism for capturing useful examples that demonstrate when modifications should result in the application of 'New Equipment' times. The grouping of similar topics in this guidelines avoids several definitions being introduced for bespoke circumstances and thus prevents the Technical Rules from becoming over complicated.

While both options a) and b) were considered appropriate to address the confusion, for the reasons outlined below neither offered a perfect solution. The persistence of the issue will naturally decrease as more of the relevant equipment reaches the end of its life and is replaced. Until such time, Western Power is considering alternative non-Technical Rules solutions such as capturing details in internal guidelines.

Option a) is not considered appropriate or viable at this point in time. Numerous components of Western Power's protection systems were installed prior to 2007. It is not economically prudent to require Western Power to upgrade these components, nor would it be realistic to apply the New Equipment times to these older systems. While applying the longer Existing Equipment times to components that were installed after 2007 would be feasible and active the option a) outcome of removing the New and Existing Equipment distinction, Western Power does not consider this a prudent outcome. As such, option a) is not considered viable.

Option b) is also not recommended. The introduction of a defined term 'material change or upgrade' that is designed to be specific to the equipment covered in clause 2.9.4 of the Technical Rules is potentially confusing. Western Power considered various definitions that could be adopted. However, in each case, judgement continues to be needed in understanding whether the existing or new times should apply. As such, the introduction of a definition, even when supported by examples, does not resolve the issue sufficiently to justify amendments to the Technical Rules.

Western Power will continue to apply the current practice whereby the new equipment times are required to be meet only where all upgrades of all or part of the system enable these stricter times to be met.

5.5 Weak infeed fault conditions

Transmission protection equipment relies on a level of fault current existing on the system to function. Under weak infeed fault conditions, generating units connected to the distribution system supply a fault current that is significantly below normal load current of the installed transmission protection scheme.

In recognition of this issue, the Technical Rules were updated in March 2016 so that under weak infeed fault conditions, total fault clearance times of one of the transmission protection schemes meets the remote end total fault clearance times set out in the Rules.

5.5.1 Issue

Users connecting to the distribution system are required to fund weak infeed assessments and provide for mitigation where studies indicate investment is needed remedy issues arising from their connection i.e., where investments are requirement to satisfy the clause 2.9.4(j) of the Technical Rules.

Several refinements to the weak infeed fault condition provision were identified that would benefit Users if adopted and allow for appropriate assessment that consider the risks posed by a weak infeed:

1. Assessment should only be required where there is a high risk of sustained islanding. Weak infeed fault conditions as described in the Technical Rules only occur when there is a sustained islanding of the relevant part of the distribution system. Under normal circumstances, an island will not be sustained, and this will clear and fault contribution from generators embedded in the distribution network.

The Technical Rules requires assessment in all circumstances. This is more conservative than necessary given the nature of the problem.

2. Assessments should exclude circuit breaker failures. It is rare for sustained islanding to coincide with circuit breaker failure. The inclusion of this scenario in current assessments therefore adds an unnecessary level of complexity.
3. Clarity is needed regarding the practicable point of assessment. The Technical Rules do not specify how deep into the distribution network the assessment should consider. The lack of clarity has potential to drive inconsistent approaches and for some assessments to be more detailed than others. Western Power considers assessments that do not go beyond the remote end of the transmission line isolator are acceptable.

5.5.2 Solution options & preferred solution

Western Power proposes changes to address and clarify each of the issues outlined above. The changes proposed provide for a more reasonable and practicable approach to weak infeed assessments.

The clarifications allow for risks for be appropriately assessed and reduce the cost of assessments for Users. For new connections the changes should reduce the time needed for connection studies.

5.6 Critical fault clearance times

The maximum total fault clearance times specify the maximum fault clearance times which the transmission and distribution protection systems are designed to achieve. The maximum total fault clearance times are considered when specifying the ratings for plant and equipment as equipment may be required to safely carry fault currents for these times.

In some situations, a fault must be cleared more quickly than the maximum total fault clearance times in order to maintain power system stability. In these circumstances the Network Service Provider will identify Critical fault clearance times which are the maximum time interval by which faults must be cleared in order to preserve power system stability.

5.6.1 Issue

Clause 2.9.5(b) of the Technical Rules relates to main protection requirements and critical fault clearance times. The clause requires the main protection systems meet all of the relevant requirements under clause 2.9.2(a). Clause 2.9.5(a) states that the Network service Provider may apply critical clearance times to a part of the transmission or distribution system but the referenced clause 2.9.2(a) applies only to transmission protection system, not distribution protection system. The distribution system requirements for duplication of protection are detailed in clause 2.9.2(b).

In practice, Western Power considers applies the main protection requirements specified in clause 2.9.2 for transmission and distribution protection when assessing the ability of the main protection systems to meet critical clearing times. The reference under sub-clause 2.9.5(b) should be revised to include 2.9.2 generally (transmission and distribution) in line with clause 2.9.5(a).

5.6.2 Solution options & preferred solution

Western Power considered the following options to address the referencing issue above:

a) Change the reference to in clause 2.9.5(b) from clause 2.9.2(a) to clause 2.9.2 such that distribution system requirements are also picked up (rather than transmission only under 2.9.2(a)).

a) No change.

Western Power recommends changes consistent with option a). This is a simple change to improve consistency between related Technical Rule clause requirements.

6. User requirements

The technical requirements that Users must satisfy to connect equipment to the transmission or distribution systems are specified in chapter 3 of the Technical Rules. The chapter is separated into sections that provide technical requirements differentiated by:

- whether the User facility consumes power (i.e., is a load) or produces power (i.e., is a generating system),
- the rated capacity of the facility, and
- how the facility is connected (i.e., transmission or distribution connected).

The figure below shows the current structure of chapter 3 of the Technical Rules and the proposed structure. The structure retains a similar differentiation of requirements with adjustments made to help Users identify the requirements applicable to their facilities.

Current structure for chapter 3:
3.1 Introduction
3.2 Requirements for all Users
3.3 Requirements for connection of generating units
3.4 Requirements for connection of loads
3.5 User's protection requirements
3.6 requirements for connection of small generating units to the distribution network
3.7 Requirements for the connection of energy systems to the LV distribution system via inverters

↓

Proposed structure for chapter 3:
3.1 Introduction
3.2 Requirements for all Users
3.3 Requirements for connection of large generating systems to the transmission system or HV distribution system
3.4 Requirements for connection of loads
3.5 User's protection requirements
3.6 requirements for connection of small generating systems to the transmission system or HV distribution system
3.7 Requirements for the connection of small generating systems to the LV distribution system
3.8 Requirements for the connection of inverter energy systems connected to the LV distribution system via a standard connection service

The following sections of this submission consider the limitations, issues and proposed solutions to address identified issues relevant to chapter 3 of the Technical Rules.

6.1 Introduction

Section 3.1 of the Technical Rules provides guidance to assist Users to understand which of the technical requirements specified in chapter 3 apply to their facility.

Western Power has identified revisions to the introduction section of chapter 3 that could:

- Provide enhanced navigation assisting Users to identify applicable requirements.

- Simply drafting by consolidating information defining generating system modes of operation.

These issues are addressed in turn in the following two sections.

6.1.1 Navigation

Current issue

The introduction section provides insufficient guidance for Users to understand which technical requirements apply, particularly where their facilities include a combination of generating systems, loads and electricity storage facilities.

The problem is further exacerbated by the existing drafting of the Technical Rules, which can be ambiguous about the technical requirements applicable to particular generating systems. For example, the provisions appliable to a small generating system connected to the transmission system with a rating < 10 MW is unclear as clause 3.3.1(c) suggests that such a generator may fall beyond the scope of clause 3.3, 3.6 and 3.7 leaving the technical requirements undefined.

Existing and potential new navigational issues were considered in the context of the revised technical requirements proposed in the remainder of this chapter.

Solution options & preferred solution

Western Power considered the following options to address the above concern:

a) Extensive restructuring of chapter 3 of the Technical Rules including introduction of sections that provide specific technical requirements for electricity storage facilities and for facilities that combine load and generating systems.

b) Include additional information in section 3.1 of the Technical Rules that helps Users identify which of the technical requirements expresses in other sections of the chapter apply to their facilities.

c) No change.

Western Power proposes changes consistent with option b). The revisions introduce a new clause 3.1(d) that includes two tables identifying the technical requirements applicable to transmission and distribution connected facilities. The tables provide further differentiation by type of facility so that requirements applicable to loads, generating systems, and electricity storage facilities are clear. In addition, the subsections in chapter 3 specifying technical requirements for different types of facilities have been renamed to better describe the types of facilities they apply to. An introductory section in each of those sections further clarifies the facilities covered by the technical requirements in that section.

In the proposed changes, generating system requirements are differentiated based on the size of the generating systems. A 5 MVA threshold is used to differentiate between large and small generating systems. The 5 MVA threshold is lower than the 10 MW threshold adopted in the current Technical Rules. However, a review of contemporary practice supports adopting the lower threshold. The 5 MVA thresholds aligns with practices in the NEM specifically:

- Section 11(1)(a) of the National Electricity Law requires that any person engaged in the activity of owning, controlling or operating a generating system in the NEM must be registered as a Generator, unless exempt. AEMO has allowed a standing exemption for generating systems with a nameplate rating of less than 5 MW[47];

[47] AEMO, *Guide to generator exemptions and classification of generating units, National Electricity Market*, 1 February 2021, p. 5. Available at: External Procedures Template Mar 2015 (aemo.com.au)

- AEMO requires that all battery energy systems with a nameplate capacity of 5 MW or more must register as both a scheduled generator and a market customer[48], and
- Registration as a generator in the NEM means that generating system and battery energy storage systems need to meet the generator performance requirements specified in the NER, including the requirements to negotiate generating performance standards.

The proposed clause clarifies that electricity storage facilities must adhere to:

- the technical requirements for loads when they are consuming active power i.e., charging, and
- the technical for generating systems when they are producing active power i.e., discharging.

The proposed changes will assist Users to identify which technical requirements apply to their facility and better account for emerging technology where electricity storage facilities are concerned.

6.1.2 Modes of operation

Current issue

The existing requirements for generating systems vary depending on the mode of operation of the generating system. For example, some requirements depend on whether the generating system operates continuously in parallel to the transmission or distribution system, occasionally operates in parallel to the transmission or distribution system or only operates in parallel for short term tests.

Several revisions are proposed to clarify the requirements applicable to generating systems. Those revisions address gaps in the current Technical Rules that create ambiguity regarding the technical requirements that apply to particular generating systems. The solution proposed involves using four subsections in chapter 3 to specify technical requirements applicable to different types of generating systems:

- Clause 3.3 of the proposed Technical Rules specifies requirements for large generating systems connected to either the transmission or high voltage distribution system.
- Clause 3.6 of the proposed Technical Rules specifies requirements for small generating systems connected to either the transmission or high voltage distribution systems.
- Clause 3.7 of the proposed Technical Rules specifies requirements for small generating systems connected to the low voltage distribution systems.
- Clause 3.8 of the proposed Technical Rules specifies requirements for inverter energy systems connected to the low voltage distribution system via a standard connection service.

The modes of operation are defined in clause 3.6.2(d) of the Technical Rules. If this same approach was repeated in the revised Technical Rules, it would result in the definition of modes being repeated in various sections specifying technical requirements for generators. This approach increases the length of the Technical Rules and risks inconsistent specification of operating modes.

Solution options & preferred solution

Western Power considered the following options to address the above concern:

a) Move the clause defining operating modes to section 3.1 of the Technical Rules.

[48] AEMO, *Fact sheet – Registering a Battery System in the NEM*, November 2018, p. 1. Available at registering-a-battery-system-in-the-nem.pdf (aemo.com.au)

b) No change - resulting in operating mode definition being repeated in generating system sub-sections of chapter 3.

Western Power proposes changes consistent with option a). The revisions propose introducing a new clause 3.1(e) which retains the same definition of operating modes as appears as clause 3.6.2(d) of the current Technical Rules. This allows for more efficient drafting and reduces the risk of inconsistent definitions of operating modes for different types of generating systems across the revised Technical Rules.

6.2 Requirements for all users

Section 3.2 of the chapter 3 specifies requirements that apply to all Users. The figure below compares the structure for this section in the current Technical Rules and the revised structure recommended by Western Power. The revisions:

- Consolidate the requirements for Users to control fault current contributions and to keep fault currents within the limits specified in the transmission and distribution planning criteria.
- Clarify the main switch requirements to reduce the need for future exemptions.
- Clarify the modelling requirements.
- Include generator performance standards in the list of technical matters to be coordinated.
- Include a requirement to maintain a User performance register.
- Include an explicit provision allowing the Network Service Provider to review control and protection settings for User facilities and arrange for modification of settings where necessary to improve power system security, reliability and quality of supply.
- Require Users to ensure the design of their facilities comply with the WA Service and Installation Requirements.

The rational for each of the key revisions are presented in the subsequent sections of this submission.

Current structure of scetion 3.2 of the Technical Rules:
3.2.1 Power system performance standards
3.2.2 Main switch
3.2.3 User's power quality monitoring equipment
3.2.4 Power system simulation studies
3.2.5 Technical matters to be coordinated

Proposed structure for section 3.2 - Requirements of all users
3.2.1 Power system performance standards
3.2.2 Main switch
3.2.3 User's power quality monitoring equipment
3.2.4 Modelling data for power system simulation studies
3.2.5 Technical matters to be coordinated
3.2.6 Register of performance requirements
3.2.7 Changes to control and protection settings
3.2.8 Other installation requirements

6.2.1 Power system performance standards - Fault contribution

The power system performance standards require that fault levels on the transmission and distribution system stay within equipment fault ratings. This requirement appears in clause 2.5.6 and 2.6.4 in the proposed Technical Rules, which reflect a similar requirement that appears as clause 2.5.7 in the current Technical Rules.

Current issue

Clause 3.6.6 of the current Technical Rules places obligations on small generators to manage the additional fault current they inject into the distribution system. With the restructure of chapter 3 there is an opportunity to reposition this requirement as a general requirement for all generating systems. This approach does not change the obligations on Users connecting generating systems but expresses those obligations more clearly. This is achieved by specifying the obligations for both transmission and distribution connected generation in the same clause.

Solution options & preferred solution

Western Power recommends including new clauses 3.2.1(f)(4) and (5) that express the requirements for all generating systems to manage their contribution to fault currents. Specifying the requirement within section 3.2.1 is preferable to the alternative of replicating the requirement within each of the sub-sections in chapter 3 that define technical requirements for different types of generating systems as it allows for more efficient and consistent specification of requirements.

6.2.2 Main switch requirements

User are required to have an appropriate means of disconnecting their facilities from the transmission or distribution system. These requirements are specified as main switch requirements in the Technical Rules.

In the current Technical Rules clause 3.2.2 specifies that all Users apart from large generators must be able to de-energise its own equipment without reliance on the Network Service Provider. The various sub-clauses in chapter 3 provide additional main switch requirements that apply to the different types of User facilities:

- Clause 3.3.3.10 specifies conditions under which a Network Service Provider’s circuit breaker can be used as a point of de-energisation for large transmission connected generating systems avoiding the cost of an additional transmission circuit breaker,
- Clause 3.6.7.2 specifies additional main switch requirements for small generating systems connected to the distribution system, and
- Clause 3.7.6.2(a) specifies additional main switch requirements for inverter energy systems connected to the low voltage distribution system.

Current issue

Western Power identified the following issues with the main switch requirements specified in Chapter 3:

- The proposed addition of sub-sections into chapter 3 that provide greater clarity on the technical requirements for different types of generators requires revision of how the main switch requirements are specified.
- The main switch requirements for distribution system connected generators have been the source of many exemption requests. Over 170 exemptions have been processed since the Technical Rules commenced. The majority of these were associated with low voltage distribution connections.

Clarifying the main switch requirements for these generators would minimise the need for future exemptions.

Solution options & preferred solution

Western Power considered the following options to address the identified issues:

a) Expand the main switch requirements for all Users to include common provisions that apply to any User connecting to the low voltage distribution network and introduce a requirement for all User facilities connected to the low voltage distribution network to comply with AS/NZS 3000. This should substantially reduce the need for future exemptions as arrangements that comply with AS/NZS 3000 will now meet the requirements in the Technical Rules.

b) In addition to option a) introduce clauses that specify additional main switch requirements applicable to different types of generating systems:

   i) new clause 3.3.12.2 specifying additional main switch requirements for large generating system based on the requirements in clause 3.3.3.10 in the current Technical Rules with appropriate modifications to allow for the possibility of a distribution connected large generating system.

   ii) new clause 3.6.6.2 specifying additional main switch requirements for small generating systems connected to the high voltage distribution system or the transmission system. The requirements are based on those appearing in clause 3.6.7.2 in the current Technical Rules.

   iii) new clause 3.7.6.1 specifying additional main switch requirements for small generating systems connected to the low voltage distribution system.

   iv) new clause 3.8.5.1 specifying additional main switch requirements for inverter energy system connected to the low voltage distribution system via a standard connection service.

c) Remove the main switch requirements for all Users and introduce new clauses into the various subsections in chapter 3 to independently specify the main switch requirements for the different types of Users.

Western Power proposes changes consistent with option b). This approach provides more efficient drafting and reduces the risk of introducing inadvertent inconsistencies between the main switch requirements that are common to all User facilities. It also allows for differences within the relevant dedicated subsection as appropriate.

Adopting the proposed revisions should reduce the need for exemptions to the main switch requirement, by clarifying the requirements applicable to Users connecting generating systems to the distribution system.

6.2.3 Modelling data for power system simulation studies

Current issue

As noted in section 3.9 of this submission, Western Power proposes introducing a requirement for the Network Service Provider to maintain a generator and load model guideline that defines the requirements Users must satisfy when providing modelling information for their facilities. Adopting the proposed revisions requires amendments to the User modelling requirements specified in chapter 3 of the Technical Rules.

Solution options & preferred solution

Western Power proposes revisions to clause 3.2.3 of the Technical Rules that simplify the specification of modelling requirements. The proposed drafting clarifies that all Users must supply modelling information as specified in the generator load and model guidelines.

Additional details regarding the model provision requirements for large generating systems are specified in clause 3.3.11 of the proposed Technical Rules.

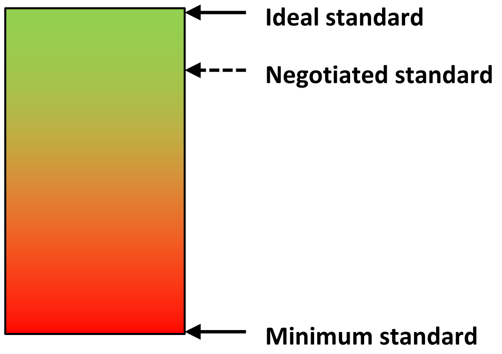
6.2.4 Extend technical matters to be coordinated to include generator performance standards

Section 3.2.5 in the current Technical Rules lists matters that the User and the Network Service Provider must agree upon.

Current issue

The existing list of matters does not include the generator performance standards for large generating systems, which creates an inconsistency with the proposed requirement for Users to negotiate generator performance standards for all large generating systems (see section 6.3.1 of this submission for the proposed requirement).

The revisions to section 3.3.4 of the proposed Technical Rules introduce a framework allowing the Users connecting large generating systems to negotiate a set of generator performance standards. The negotiation process reflects that specified in the WEM Rules for transmission connected generators participating in the WEM. Each performance standard addresses a particular technical requirement, and the level of performance must be as close to the specified ideal performance standards as is practicable and must not fall below the minimum standard as illustrated in the following diagram.



Solution options & preferred solution

Western Power recommends extending the list of matters to be coordinated to include generator performance standards for large generating systems.

6.2.5 User performance register

As discussed in section 6.3 of this submission, revisions have been proposed to the requirements for generating systems to ensure these systems support the ongoing maintenance of system security. The proposed revisions to the generating system requirements in chapter 3 work in tandem with the enhanced compliance arrangements proposed for chapter 4 of the Technical Rules (as discussed in section 7.4 of this submission) to provide ongoing confidence that generators will contribute the technical requirements necessary to maintain power system security.

Given the importance of generators meeting their technical requirements, it is critical that those requirements are well documented and readily accessible to the Network Service Provider, AEMO and the relevant generator.

Current issue

The current version of the Technical Rules does not place any explicit obligation on the Network Service Provider to document generator technical requirements. Failure to address this gap could lead to confusion regarding the technical requirements applicable to individual generating systems.

As part of the connection process, the Western Power requires Users to produce a Technical Rules Compliance Report that contains content demonstrating the User is complying with the relevant areas of the Technical Rules. The final version of a Technical Rules Compliance Report for particular connection works must be accompanied by certification from a Chartered Professional Engineer with National Professional Engineers' Register Standing that the plant is ready for commissioning.[49] Currently, information and evidence, including compliance test plans and results that demonstrates User compliance with the condition of connection are included within the Technical Rules Compliance Report. Hence the relevant information is already being captured and there is an opportunity to formalise the process within the Technical Rules.

Solution options & preferred solution

Western Power considered the following options to address the identified issue:

a) Create new clauses in section 3.2 of the Technical Rules that requires the Network Service Provider to:

   i) maintain a User Performance Register capturing the performance standards negotiated for large generating systems, relevant generating system models, compliance monitoring plans and records produced by User to demonstrate ongoing compliance of larger generating systems with their generator performance standards,

   ii) provide AEMO and the Authority with access to the register on request, and

   iii) provide Users with access to the information in the register for their larger generating system on request.

b) In addition to option a), extend the User Performance Register to also capture key technical requirements for large loads.

c) In addition to option b), extend the User Performance Register to capture technical requirements for all generating systems and loads.

d) No change – rely on existing approaches to capture information.

Western Power proposes changes consistent with option b). This approach captures information in the User Performance Register for those facilities that are likely to have the most significant impact on power system security. It is particularly important that the information for large generating systems is captured as Users controlling large generating systems have the opportunity to negotiate performance standards for their generating systems by applying the negotiation processes defined in either the WEM Rules or the Technical Rules (as discussed in section 6.3.1 of this submission).

Extending the scope of the User Performance Register to capture technical requirements for smaller generators is not recommended. Those generators all face with a common set of performance

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[49] Western Power, *Technical compliance report (TCR) and guidelines,* 3 August 2017. Available at: https://westernpower.com.au/media/2457/technical-compliance-report-and-guidelines-20170726.pdf

requirements and do not have the opportunities to negotiate performance standards. This means these bespoke performance requirements will not exist, which lessens the need to capture individual performance requirements in the User Performance Register.

Option b) is also preferred as it will allow for alignment between the User Performance Register required by the Technical Rules and the GPS register required under clause 3A of the WEM Rules.

6.2.6 Review of User control and protection settings

Various clauses in chapter 3 specify technical requirements that must be met by User facilities. Satisfying those requirements will generally require specific settings be applied to control and protection systems at User facilities. Those settings can have a significant impact on the performance of the User facilities and the impact those facilities have of the ability to maintain power system security and to meet the power system performance standards.

Consistent with the potential power system security impact, Chapter 4 of the Technical Rules includes provisions that require the Network Service Provider to approve any changes to control and protection settings.

Current issue

As the power system evolves it may become necessary to adjust control and protection settings to optimise the performance of the power system and to maintain power system security. The Technical Rules currently do not provide any explicit provisions allowing the Network Service Provider to review control and protection setting and, where necessary, request changes to settings to improve power system security, reliability or quality of supply to other Users.

Solution options & preferred solution

Western Power has proposed introducing a new clause 3.2.7 to address this issue. The new clause:

- Recognises that the Network Service Provider may review the control and protection system settings within for a User’s facility and, where necessary, may require the User to implement setting changes to improve power system security, reliability or quality of supply to other Users.
- Requires the User to implement any recommended changes to settings.

6.2.7 System design and construction standards

Current issue

Clause 2.7 of the Technical Rules requires the Network Service Provider ensure that the transmission and distribution systems comply with key requirements including:

- the Technical Rules,
- Electricity (Network Safety) Regulations 2015,
- relevant codes, standards and regulations such as the Access Code, Australian and International Electricity Commission (IEC) Standards, and
- relevant Electricity Networks Association Guides.

To ensure the distribution system complies with these technical requirements, Western Power requires that Users facilities must comply with the requirements of the WA Service and Installation Requirements. The Technical Rules however do not explicitly express this requirement.

Solution options & preferred solution

Western Power has proposed introducing a new clause 3.2.8 to address this issue. The new clause requires that Users connecting to the distribution system must ensure that the design of their facilities complies with the WA Service and Installation Requirements. This approach reinforces existing practice[50] and should not add any additional cost to Users seeking to connect to the distribution system.

6.3 Large generators

Section 3.3 in Chapter 3 of the Technical Rules specifies requirements that apply to large generating systems. The figure below compares the structure for this section in the current Technical Rules and revised structure recommended by Western Power.

Structure in the current Technical Rules:
3.3.1 General
3.3.2 Provision of information
3.3.3 Detailed technical requirements requiring ongoing verification
3.3.4 Monitoring and control requirements
3.3.5 Power station auxiliary transformers
3.3.6 Synchronising
3.3.7 Secure electricity supplies
3.3.8 Design requirements for generator's substations
3.3.9 Computer model

Proposed structure for section 3.3 - Requirements for connection of large generators
3.3.1 Overview
3.3.2 General requirements
3.3.3 Provision of information
3.3.4 Establishing generator performance standards
3.3.5 Potential relevant generator modifications to existing generating systems
3.3.6 Relevant generator modifications to existing generating systems
3.3.7 Technical requirements addressed by generator performance standards
3.3.8 Remote monitoring requirements
3.3.9 Remote control requirements
3.3.10 Communication equipment requirements Other installation requirements
3.3.11 Generation system model
3.3.12 Safe shutdown without external electricity supply
3.3.13 Restart following restoration of external electricity supply
3.3.14 Generating unit transformer
3.3.15 De-energisation of Generator circuits
3.3.16 Power station auxiliary transformers
3.3.17 Synchronising
3.3.18 Secure electricity supplies
3.3.19 Design requirements for generator's substations

The key revisions include:

- Introducing generator performance standards to clarify Users technical performance requirements, support maintenance of power system security and align with changes to WEM Rules. These changes

[50] User connecting to the distribution system are currently required to meet requirements in the Western Australian Distribution Connection Manual. The WA Service and Installation Requirements documents is the updated name for this Manual.

also allow negotiation of bespoke performance requirements, which should reduce the need for exemptions.

- Clarifying the treatment of modifications to generating systems that impact their ability to achieve technical requirements.
- Clarifying remote control and monitoring requirements.
- Clarifying protection requirements.
- Revisions required to ensure the technical requirements are applicable both distribution and transmission connected large generators.

The rational for each of the key revisions are presented in the subsequent sections.

6.3.1 Generator performance standards framework

Individually, large generating systems have the ability to impact the performance of the power system. It is important that the technical requirements for these generating systems are set appropriately to maintain power system security, reliability and the ability to meet the power system performance standards.

Recent revisions to the WEM Rules have introduced a generator performance standards (GPS) framework, which aims to provide a more appropriate specification of technical performance requirements for large transmission connected generators that participate in the WEM.

Current issue

Western Power has identified a number of concerns with the specification of technical requirements for large generating systems in section 3.3 of the current Technical Rules:

- The existing specification of technical requirements is biased toward a power system dominated by large synchronous generators, with many requirements not specified in a manner suitable for large inverter connected generating systems.
- The specification of the same technical performance requirement for all large generating system limits the ability to optimise performance requirements taking into account the characteristics of proposed generating systems and the transmission system at the proposed point of connection. This gives rise to a less efficient connection process forcing connecting parties through an exemption process to negotiate bespoke performance requirements.
- The technical requirements for large generating systems do not always cater for large distribution connected generating systems.
- The requirements in the current Technical Rules differ significantly from the requirements encapsulated in the GPS framework introduced in the WEM Rules. This creates the potential for significant misalignment of the requirements that a larger generating system faces depending on whether those requirements are established via the process in the WEM Rules or the Technical Rules.

Solution options & preferred solution

Western Power considered the following options to address the above issues:

a) Implement a GPS framework in the Technical Rules that replicates the requirements in the WEM Rules and that applies to large generating systems not covered by the WEM Rules (see section 6.3.2 of this submission). The performance standards specified in the WEM Rules are consistent with contemporary practice in the NEM and address the technology bias in the current Technical Rules. The framework allows for Users to be able to negotiate a bespoke set of generator performance standards for each of their large generating systems. A generator performance standard is negotiated for each of the following 11 technical requirements:

- Active power capability
- Reactive power capability
- Voltage and reactive power control
- Active power control
- Inertia and frequency control
- Frequency disturbance ride through
- Voltage disturbance ride through
- Multiple disturbance ride through
- Disturbance ride through for partial load rejection
- Disturbance ride through for quality of supply
- Quality of electricity generated

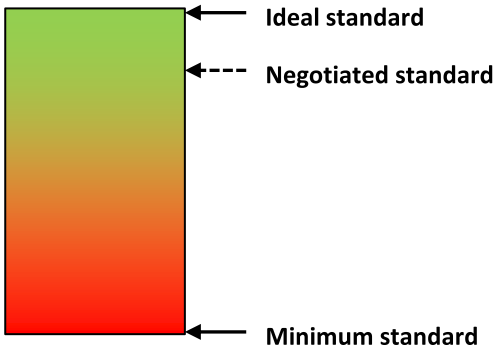
Each performance standard must be set as close as practicable to the level of performance specified in the ideal generator performance standard and can be set no lower than the level of performance specified in the minimum generator performance standard.

b) In addition to option a), make appropriate adjustments to the specification of minimum and ideal generator performance standards to accommodate connections to the high voltage distribution system.

c) No change - Maintain arrangements in the Technical Rules that are not aligned with those in the WEM Rules.

Western Power proposes changes consistent with option b). This approach best addresses the identified issues.

Option b) establishes a process for negotiating GPS, with the negotiated standard set at a level of performance no less onerous than the minimum standard and as close as practicable to the ideal standard.



This option means that large generating systems face a consistent set of performance requirements regardless of whether they are negotiated through the process in the WEM Rules or the Technical Rules. The proposed changes implement revisions to the Technical Rules that align with the GPS provisions in the WEM Rules as of 30 July 2021 (or a later date if there are delays)[51]. To ensure consistency moving forward,

[51] The Technical Rules have been drafted to align with WEM Rules that are in the process of being approved for gazettal. At the time of writing the most recent minor changes were expected to be finalized on 30 July 2021. Given the minor nature of these changes, Western Power considered it prudent to adopt the draft changes now rather than updating the Technical Rules to re-align at a later date.

any revisions to the generator performance standards in the WEM Rules should be reflected as changes to the Technical Rules.

The proposed negotiating framework should help limit the need for exemptions in the future particularly given that the minimum generator performance standard generally captures the relaxation of technical requirements previously granted to generators through the Technical Rules exemptions process.

Option b) is implemented via the following revisions to section 3.3 of the proposed Technical Rules:

- Clause 3.3.4 of the proposed Technical Rules specifies the process to be followed to negotiate GPS via the Technical Rules. As noted in section 6.3.2 generator must follow the process in the Technical Rules unless performance standards have been negotiated via the process in the WEM Rules or an exemption granted via the mechanism in the WEM Rules.
- Clauses 3.3.5 and 3.3.6 of the proposed Technical Rules specify processes for identify relevant modifications to large generating systems and assessing requests to undertake those modifications including the need for potential renegotiation of generator performance standards. These provision as discussed further in section 6.3.3.
- Clause 3.3.7 of the proposed Technical Rules specify the requirements than must be satisfied by each of the 11 generator performance standards.

6.3.2 Exemptions for generators with GPS by the WEM Rules

The GPS provisions proposed for large generators in the Technical Rules are intended to align with the GPS arrangements in the WEM Rules. Large generators play a critical role in power system security and so it is appropriate to ensure they are adequately covered via the WEM Rules process or in Technical Rules.

Current issue

In the absence of clarity, there may be confusion about the need to apply both the WEM Rule and Technical Rule GPS processes. Applying both processes would be duplicative and unnecessary as they are designed to cover the same power system risks.

Further, the need to apply or not apply for an exemption from the Technical Rules where a GPS process is agreed under the WEM Rules may be unclear. The intention of the changes to avoid exemptions should be made clear in the changes.

Solution options & preferred solution

Western Power considered the following solutions:

a) Introduce clauses in Chapters 1, 3 and 4[52] and drafting notes in relevant sections of the Technical Rules that clarifying that the Technical Rules GPS process does not apply, and no exemption is required from the Technical Rules where a generator has agreed GPS or received an exemption from GPS in accordance with the WEM Rules. Clarify in notes that generators must comply with all other relevant provisions in the Technical Rules.

b) Rely on the hierarchy established through the lead legislation and regulations to inform generators of the precedence of the WEM Rules over the Technical Rules. Revisions to the Access Code included a new clause A6.2 that states “Technical Rules are not required to address the matters listed in clause

52 Refer to clauses 1.9.1(f), 3.3.4.1 and 4.2.2(d) of the proposed Technical Rules.

A6.1 to the extent that these matters are dealt with in Chapter 3A or Appendix 12 of the Market Rules."[53]

Option a) is preferred as it make the application of the WEM Rules and Technical Rules clearer for generators that need to meet requirements in the documents.

Generators who negotiate GPS or receive an exemption from requiring GPS under the WEM Rules should not have to go through a similar process under the Technical Rules as the risks being addressed are adequately covered by the WEM Rules. The preferred option clarifies that no exemption is needed from the Technical Rules if the generator has agreed GPS under the WEM Rules or has been exempted from the WEM Rules GPS process. It avoids confusion and potential duplication.

6.3.3 Treatment of relevant generator modifications

Current issue

The changes in clause 3.3 of the Technical Rules introduce similar GPS arrangements to those in the WEM Rules for large generators (>5 MVA) both transmission and distribution connected. The WEM Rules also introduce a relevant generator modification framework. The framework requires that when generators undertake relevant changes to their equipment, they face an obligation to meet the current GPS. Where appropriate, a relevant generator modification can also give rise to the need for compliance testing and commissioning to verify the required performance is achieved.

A relevant generator modification framework is not adequately covered in the current Technical Rules[54], which creates the potential for ambiguity regarding the technical requirements that need to be met by a modified generator. Developing a relevant generator modification framework for the Technical Rules would help address this concern and would provide the opportunity to clarify the testing requirements following commissioning of a relevant generator modification. Aligning the relevant generator modification framework in the Technical Rules with that in the WEM Rules will also benefit Users by ensuring a consistent approach for all large generating systems.

Solution options & preferred solution

Western Power considered the following solutions:

a) Revise chapter 3 of the Technical Rules to implement a relevant generator modification framework reflecting that adopted in the WEM Rules and ensure that relevant generator modification requires compliance testing in accordance with chapter 4. Modify chapter 4 to ensure AEMO is notified of any identified non-compliances and informed regarding any rectification processes (i.e., reciprocal arrangements to those in the WEM Rules). With this approach, the WEM Rules definition for relevant generator modification is adopted in the Technical Rules.

b) In addition to Option a), extend the scope of the guideline produced by the Network Service Provider in accordance with clause 1.9.4(d) to provide examples relevant generator modifications.

Option b) is preferred. Larger generators captured by the Technical Rules may not be participating in the WEM and may be either transmission or distribution connected. It is therefore appropriate that the Technical Rules include a relevant generator modification framework similar to that in the WEM Rules.

53 Energy Policy WA, *Draft Changes to the Electricity Networks Access Code*, 14 May 2020. Available at: https://www.wa.gov.au/government/publications/energy-transformation-strategy-proposed-access-code-changes

54 Clause 1.9.4 of the Technical Rules considers some modifications and upgrades.

The key revisions proposed to implement the relevant generator modifications framework in the Technical Rules are:

- Introduction of a new clause 3.3.5 defining the process followed to assess whether a potential relevant generator modification should be treated as a relevant generator modification,
- Introduction of a new clause 3.3.5 defining the process to seek approval from the Network Service Provider prior to undertaking any relevant generator modification,
- Revision of clause 1.9.4(d) to extend the scope of the guideline to include relevant generator modifications, and
- Revisions to chapter 4 to address compliance testing required as a result of undertaking a relevant generator modification.

The alignment with updated clause 1.9.4(d) of the Technical Rules (discussed in section 2.6 of this submission), links guidance on related requirements in the Technical Rules – both clause 1.9.4 and the relevant generator modification framework consider upgrades and modifications that trigger a requirement to comply with the current Technical Rules.

6.3.4 Remote control and monitoring

It is important to ensure appropriate remote control, monitoring and communication facilities are provided for each large generating system. Appropriate remote control and monitoring assist the Network Service Provider and AEMO to manage system security by providing appropriate visibility of the status of large generating systems and their ability to provide technical performance consistent with their GPS.

Current issue

Western Power identified the following issues with the remote control, monitoring and communication requirements for large generators defined in clause 3.3.4 in the current Technical Rules:

- There is a lack of clarity regarding the standards that Users should comply with in designing their remote control, monitoring and communication requirements.
- The existing drafting suggests that provision of remote monitoring may not be required in all instances. Western Power considers that remote monitoring of all large generating systems is required to manage power system security.
- The list of signals to be monitored is explicitly specified in the Technical Rules, which creates the risk that the list may not cater for all technologies or be appropriate for all large generating systems.
- The requirements for a backup speech communication channel outlined in clause 3.3.4.3(d) of the current Technical Rules are no-longer necessary given the variety of electronic communications options available today.

Solution options & preferred solution

Western Power propose the following changes to address the identified issues:

- Introduce new clauses 3.3.8, 3.3.9 and 3.3.10 that specify requirement for remote monitoring, remote control and communication systems respectively.
- Introduce a requirement via clause 5.8.1(b) of the proposed Technical Rules for the Network Service Provider to develop a generating system control and monitoring guideline (as discussed in section 8.6 of this submission)

- Including in clauses 3.3.8, 3.3.9 and 3.3.10 of the proposed Technical Rules the requirement to provide remote control, monitoring and communication systems consistent with the generating system control and monitoring guideline. This allows the explicit list of signals to be retained so that User have clarity on the requirements but removes the list from the Technical Rules to the guideline where the list can be more readily monitored maintained.
- Delete the requirement for a backup speech communication channel.

These changes benefit Users by providing greater clarity regarding the requirements for remote monitoring, control and communication systems and remove the outdated requirement for a back-up speech communications channel. Utilising the guideline to provide detailed guidance provide a more efficient means of providing updated information by avoiding the need for amendment of the Technical Rules.

6.3.5 Protection requirements

As noted in section 6.8.1 of this submission, Western Power recommends consolidating the User protection requirements in section 3.5 of the Technical Rules to address issues identified with the existing fragmented definition of User protection requirements. To support this change, two new subclauses are proposed for clause 3.3.2 that link the protection requirements to relevant parts of the new section 3.5:

- A large generating system connected to the transmission system (3.3.2 (g) of the proposed Technical Rules), and
- A large generating system connected to the high voltage distribution system (3.3.2 (h) of the proposed Technical Rules).

6.3.6 Accommodating distribution connected large generating systems

As outlined in section 6.3.1 in this report, the proposed requirements for section 3.3 of proposed Technical Rules are based on WEM Rule requirements that apply to transmission connected generators that are Market Participants (under the WEM Rules).

Current issue

Several of the current technical requirements in section 3.3 of the current Technical Rules need revision to ensure that they expressed appropriate requirements for connection to the transmission system or the high voltage distribution system.

Solution options & preferred solution

Western Power proposed various revisions across section 3.3 of the Technical Rules to ensure that the requirements for both transmission and high voltage distribution connections are clearly defined. In many instances this involved replacing references to the transmission system with references to the transmission and high voltage distribution system.

For the following technical requirements, additional clauses were added where it was necessary to vary the requirements for a transmission or distribution connection:

- Clause 3.3.15.1 of the proposed Technical Rules specifies main switch requirements for transmission connected large generating systems, while the requirements for those large generating systems connected to the high voltage distribution system are specified in clause 3.3.15.2.
- The specification of voltage ride through performance standards in clause 3.3.7.8 were extended beyond those specified in the WEM Rules to provide ride through requirements for the transmission

and distribution system. The requirements expressed in the WEM Rules are applicable for transmission connected generating systems participating in the WEM. The requirements needed to be extended to include voltage ride through requirements applicable to generating systems connected to the distribution system.

6.4 Small generators connected to the transmission or high voltage distribution system

Section 3.6 in the proposed Technical Rules specifies the requirements that Users must meet for small generating systems (aggregate rated capacity ≤ 5 MVA) connected to the transmission system or the high voltage distribution system. The requirements in this clause have been developed by implementing a series of revisions to the requirements specified in section 3.6 of the current Technical Rules.

Western Power proposes changes to the structure of section 3.6 to reflect the revised focus of the section and to align with other structural changes implemented across chapter 3. Figure 6-1 illustrates the key structural changes proposed for section 3.6. The main changes result from the consolidation of the protection requirements into section 3.5 (as discussed in section 6.8.1 of this submission).

The key revisions proposed to the requirements for the connection of small generating systems to the transmission or high voltage distribution system include:

- Adopting appropriate technical requirements that cater for all generation technologies, appropriately leveraging the GPS requirements for large generators and providing appropriate alignment with the requirements in the most recent inverter standard AS/NZS 4777.2.
- Clarifying main switch requirements as discussed in section 6.2.2 of this submission.
- Introducing requirements to allow the Network Service Provide to specify export limits that should help maximise embedded generation hosting capacity and avoid more restrictive connection arrangements.
- Adjusting requirements to ensure they are applicable to all small generators connected to either the transmission system or the high voltage distribution system.
- Clarifying communication system requirements.

The rational for each of the key revisions are presented in the subsequent sections.

Figure 6-1: Overview of small generating system requirements specified in section 3.6

Structure of section 3.6 in the current Technical Rules:
3.6.1 Overview
3.6.2 Categorisation of Facilities
3.6.3 Information to be provided by the Generator
3.6.4 Safety and Reliability
3.6.5 Requirements of clause 3.3 applicable to small power stations
3.6.6 Generating unit characteristics
3.6.7 Connection and Operation
3.6.8 Power Quality and Voltage Change
3.6.9 Remote Control, Monitoring and Communications
3.6.10 Protection
3.6.11 Intertripping
3.6.12 Failure of Generator's Protection equipment
3.6.13 Commissioning and Testing
3.6.14 Technical matters to be coordinated

Proposed structure for section 3.6 - Requirements for the connection of small generating systems to the transmission or high voltage distribution system:
3.6.1 Overview
3.6.2 Categorisation of facilities
3.6.3 Information to be provided by the Generator
3.6.4 Safety and reliability
3.6.5 Technical requirements
3.6.6 Connection and operation
3.6.7 Power quality and voltage change
3.6.8 Remote control, monitoring and communications
3.6.9 Commissioning and testing
3.6.10 Technical matters to be coordinated

6.4.1 Appropriate technical requirements for small generating systems connected to the transmission or distribution system

Section 3.6 in the current Technical Rules specifies requirements for distribution connected small generating systems. Many of the technical requirements specified in this section of the Technical Rules leverage the requirements for large generating systems specified in section 3.3 in the current Technical Rules.

Current issue

The technical requirements for small generating systems need revision to address the following issues:

- Some of the technical requirements are specified in a manner that is biased toward synchronous generation technology. Given that the majority of new generation being connected to the power system is inverter-based non-synchronous generation, requirements need to be expressed in a manner which is equally applicable to inverter-based generation technology.

- The provisions in section 3.6 in current Technical Rules fail to address some of the important technical requirements covered by the GPS introduced for large generating systems. Key gaps include limited specification of disturbance ride through requirements and inequitable requirements for primary frequency response.
- The latest version of AS/NZS 4777.2 specifies significantly improved functional requirements for inverters used to connect generator the power system. The existing provision in section 3.6 should be revised to take advantage of the additional capability provided by AS/NZS 4777.2 compliant inverters.

Solution options & preferred solution

Western Power considered the following solutions to address these issues:

a) Revise the technical requirements in section 3.6 of the Technical Rules to implement technical requirements for small generating systems that are equivalent to those specified for large generating systems, requiring negotiation of generator performance standards for all small generating systems.

b) Where appropriate align the technical requirements for small generating systems with minimum performance standards specified for larger generating systems.

c) In addition to b) incorporate revisions into the technical requirements that leverage capability available in AS/NZS compliant inverters.

Option c) is preferred. This option addresses all the identified concerns:

- Leveraging the minimum performance standards developed for the large generating systems will address the technology bias concerns. The minimum performance standards have been developed considering those used in the NEM with appropriate variations adopted to suit the characteristics of the SWIS. The NEM requirements have been developed and reviewed by the Australian Energy Market Commission and are generally free of technology bias.
- The adoption of the minimum standard to set the requirement for small generating systems is appropriate and reflects that these systems are less likely to impact power system security compared to larger generating systems. Requiring alignment with the more onerous ideal generator performance standard is therefore unnecessary.
- Leveraging the generator performance standards addresses gaps in the current technical requirements for small generating systems.
- Adopting appropriate revisions to leverage the capability of AS/NZS 4777.2 compliant inverters will reduce the cost for Users while maintaining the security of the power system. The revisions recognise that the capability provided by inverters which comply with the latest standard is in many cases sufficient to meet performance requirements thereby avoiding unnecessary additional investment.

Option a) is not currently recommended as it would require a significant increase in the level of effort required from Users and Western Power to manage the connection of small generating systems. The more complex process for negotiating performance standards does not providing the appropriate balance between the complexity and cost of the connection process and the potential system security issues that could result from the connection of individual small generating systems.

The following key revisions are proposed to implement option c):

- Clause 3.6.5 specifies the technical requirements that small generating systems connected to the transmission or the high voltage distribution system must meet. The drafting efficiently references the minimum performance standards in section 3.3.7 to specify the requirements.

- The aggregate capacity of the small generating system dictates which minimum performance standards they need to meet. Small generating systems with an aggregate capacity >150 kVA are required to meet a broader set of minimum performance standards than other small generating systems. This approach adopts a similar threshold to clause 3.6.5 in the current Technical Rules.
- The relaxation to disturbance ride through requirements for small generating systems with an aggregate rated capacity ≤ 150 kVA allowed in clause 3.6.5 aligns required performance with that specified in AS/NZS 4777.2

6.4.2 Export limits for transmission and distribution connected small generating systems

The ability to host renewable generation on the power system can be enhanced if Western Power is able to impose export limits on all generating systems. In the absence of export limits more restrictive limits may need to be applied via the connection process to avoid connected generation exceeding available network capacity. The ability to impose export limits allows greater hosting capacity by using the actual power system conditions to adjust the notified export limits.

In the absence of the ability to specify export limits that can be adjusted to cater for actual system conditions, Western Power may need to impose restrictions on the connection of embedded generation to prevent insecure or unsafe operation of the distribution system.

Current issue

The Technical Rules currently lack explicit provisions allowing the Network Service Provider to specify an export limit for small generating systems and requiring the Users to operate to within those limits. The existing provisions for small generating systems include export limits as a protection rather than a control measure.

The proposed performance standards for larger generating system provide the ability to set active power limits and thereby enforce an export limit.

Solution options & preferred solution

Western Power considered the following options to address the issue:

a) Introduce new clauses that allow the Network Service Provider to specify an export limit where necessary to ensure safe, reliable and secure operation of the power system; and require the User to control the active power from their small generating system to remain below the export limit.

b) Option a) with the application of export limits restricted to only small generating systems connected to the transmission system or the high voltage distribution system (i.e., User facilities covered by clause 3.6 of the proposed Technical Rules).

Option a) is preferred as this approach addresses all the identified concerns and provides an approach which is best able to maximise hosting capacity at all voltage levels in the distribution network. Allowing the Network Service Provider to specify export limits should help maximise embedded generation hosting capacity and avoid more restrictive connection arrangements. The latest version of AS 4777.2 requires that inverters are able to receive and operate to stay within specified export limits, as such export limits can readily be accommodated by Users that install inverters compliance with the latest Australian Standard. The proposed changes are therefore unlikely to increase connection costs for Users.

The recommended option is implemented through the following new clauses added to sections 3.6, 3.7 and 3.8 of the proposed Technical Rules:

- Clause 3.6.6.5 – export limit control, which applies to small generators connecting to the transmission and high voltage distribution systems,
- Clause 3.7.6.4 – export limit control, which applies to small generators connecting to the low voltage distribution system, and
- Clause 3.8.5.2 – export limit control, which applies inverter energy systems connecting to the low voltage distribution system.

6.4.3 Accommodating transmission and distribution connected small generating systems

As outlined in section 6.4.1 in this report, the proposed requirements and therefore the drafting for section 3.6 of proposed Technical Rules mirrors that adopted for section 3.3 of the proposed Technical Rules.

Current issue

Several of the current technical requirements in section 3.6 of the current Technical Rules need revision to ensure that they expressed appropriate requirements for connection to the transmission system or the high voltage distribution system.

Solution options & preferred solution

Western Power proposed various revisions across section 3.3 of the Technical Rules to ensure that the requirements for both transmission and high voltage distribution connections are clearly defined. In many instances this involved replacing references to the transmission system with references to the transmission and high voltage distribution system.

For the following technical requirements, additional clauses were added where it was necessary to vary the requirements for a transmission or distribution connection:

- Clause 3.6.2(c) of the proposed Technical Rules was revised to list applicable voltage level for the transmission and high voltage distribution system.
- Clause 3.6.8(a) of the proposed Technical Rules was revised to remove references to the low voltage distribution system.

6.4.4 Communication system requirements for small generating systems

The requirements for remote monitoring, control and communications systems for small generating systems are outlined in section 3.6.9 of the current Technical Rules.

Current issue

The requirements section 3.6.9 concerning the communication system requirements for small generating systems are outdated and require amendment to reflect the capability of modern communication systems and to reflect the reduced importance of back-up speech communication channels for enabling power system operations.

Further, the current requirements for installation of remote monitoring, control and communications systems are triggered based on aggregate export limits. Setting requirements based on generator capacity would be consistent with the requirements in other Australia jurisdictions.

The lack of appropriate triggers to require remote monitoring, control and communications systems, including on smaller system, means that Western Power does not have visibility of how some generators are interacting with the power system including during critical minimum load periods. Going forward, as the minimum load continues to fall, there is an increasing need to monitor and potentially control smaller generators to ensure system security including where the Network Service Provider is directed by AEMO.

Solution options & preferred solution

Western Power recommends the following revisions to address the identifies issues and provide communication system requirements that are aligned with modern requirements and meet operational requirements:

- Update clauses in 3.6.8 of the proposed Technical Rules to specify requirements for remote monitoring, control and communications systems are triggered based on generating system capacity rather than an export limit.
- Introduce revisions to clauses 3.6.8(c) of the proposed Technical Rules requiring Generators to provide a continuous communications link to the Network service Provider's control centre where the Generators are required (in accordance with other clauses) to implement remote monitoring and control.
- Introduce revisions to clauses 3.6.8(d) of the proposed Technical Rules that remove the requirement for a back-up speech communications channel.
- Introduce clauses 3.7.8 and 3.8.6(b) of the proposed Technical Rules, which make the requirements in clause 3.6.8 apply to all small generating systems connected to the low voltage distribution system.

The removal of obsolete requirements should reduce costs to Users and the change to specify requirements based on generating system capacity aligns with practice in other jurisdictions. The revised clauses will enable the Transmission Network Operator and Distribution Network Operator to perform roles as outlined in Chapter 5 of the proposed Technical Rules.

6.4.5 Reconfirmation of correct operation

Clause 3.7.8.3 of the current Technical Rules, which applies only to energy systems connected to the low voltage distribution network via invertor, allows for the Network Service Provider to inspect the installation covered by the current section 3.7 of the Technical Rules from time to ensure compliance with the Technical Rules. The clause also allows the Network Service Provider to disconnect the generating equipment if the Network Service Provider considers that the installation poses a threat to safety, to quality of supply or to the integrity of the distribution system.

No similar clause existing for other small generators connected. Instead, clause 4.3.1 of the current Technical Rules applies, which is the same provision used for all other generators. In addition, Attachment 12, which applies to small generators covered in the new sections 3.6 and 3.7 of the Technical Rules, provides for non-routing testing enabling the Network Service Provider to inspect and test the small power station to re-confirm its correct operation and continued compliance with the Rules, connection agreement, good electricity industry practice and relevant standards. The Attachment 12 provisions also provide for the disconnection of the generating equipment if the Network Service Provider considers there the installation poses a threat to quality of supply or to the integrity of the distribution and transmission system it may disconnect the generating equipment.

Current issue

There are several issues with the current drafting:

- Provisions for small generators not covered by clause 3.7.8.3 is difficult to locate and may be overlooked. The provisions would be better expressed in a new dedicated clause within the relevant sections of the Technical Rules.
- The current drafting implies disconnection as the primary remedy for the identification of non-compliance with the Technical Rules. Changes to settings and subsequent testing is not explicitly contemplated. However, these are potential remedies for the reconfirmation of correct operations that are less severe than disconnection.
- The Network Service Provider must consider the installation poses a threat to safety, to quality of supply or to the integrity of the distribution system to disconnect it from the system. However, as the range and number of installations on the system increases, it is increasingly difficult to determine a single installation that produces the threat to safety, to quality of supply or the integrity of the distribution system. Further, setting changes, remote control and the adherence to generation and export limits may mean the treats is only present under certain circumstances. The net effect of the range of installations may be identified as the cause of issues. To manage the risks posed by generating systems connected the low voltage network, it is more appropriate for the Network Service Provider to have broader powers for requesting changes and disconnection to deal with any non-compliance with the Technical Rules.

Solution options & preferred solution

Western Power considered the following options to address this issue:

a) Update the provision to allow the Network Service Provider to request and have the User or Generator implement setting changes and conduct testing if appropriate in additional to enabling the Network Service Provider to disconnect the installation. In addition, remove the requirement for there to be a threat to safety, to quality of supply or to the integrity of the distribution system to disconnect it from the system and instead link the provision to compliance with the relevant Technical Rules. Apply these provisions to all small generators connecting to the low voltage distribution system.

b) No change.

Option a) is the preferred option. With the proposed structural changes to separately the requirements for generators connecting to the low voltage distribution system from other connections, given the larger number of these connections expected in the future and the nature of the electrical contractor and engineering consultant workforce, it’s appropriate to include a similar clauses for all small generators (meaning those covered by sections 3.6, 3.7 and 3.8 of the proposed Technical Rules).

The changes provide better clarity on the existing provisions for small generators covered by sections 3.6 and 3.7 of the proposed Technical Rules. There is a more suitable range of options available to the Network Service Provider in managing potential issues associated with or optimally managed through changes to all small generators (including those covered in proposed sections 3.6, 3.7 and 3.8). Further, the updated drafting makes the obligation on the User or Generator on remaining compliant with the Technical Rules are clearer.

6.5 Small generators connected to the low voltage distribution system

The requirements for low voltage networks are often distinct from the requirements are applied at higher voltages. The distinction is apparent across:

- Australian Standards, with standards that are used for customer electrical installations and equipment applying uniquely to low voltages and providing prescriptive practices to be followed for those installations.
- The electrical contractor and engineering consultant workforce, where there many that install the small systems on the low voltage network do not have the same understanding, skill or experience of those working on the high voltage installations.
- The ability for oversight, where the volume of connection at low voltage means it is not possible to review each application individually.

The key changes proposed for small generators connected to the low voltage distribution system include:

- Allowing for unique sections that capture requirements for small systems connected to the low voltage distribution system based on the type of connection.
- New provisions that enable the Network Services Provider to require Users and Generators to introduce and update export and generation limit controls for smaller systems, which are needed to enable the managed growth in the number and range of small systems on the low voltage distribution system.
- New provisions that enable the Network Service Provider to require Users and Generators to install remote monitoring and control that are required for the management of the low voltage distribution system as it evolves and will facilitate future roles for aggregators and the Distribution System Operator.
- Clarifying and updating the responsibilities on Users and Generators to reconfirm correct operation of their installations as compliant with the Technical Rules, including adding new provisions that enable the Network Service Provider to request setting changes.

The rational for each of the key revisions are presented in the subsequent sections.

6.5.1 Unique requirements for small systems connected to the low voltage distribution systems

Current issue

The current Technical Rules do not explicitly differentiate the technical requirements for small generating systems connecting to the low voltage distribution system from the requirements for small generating systems connected to the high voltage distribution system. This approach has made it difficult for Users connecting at different distribution voltage levels to understand the specific requirements that apply to their generating system.

Solution options & preferred solution

Western Power considered the following options to address this issue:

a) Introduce a new section 3.7 to separately identify the requirements for all small generating systems connected to the lower voltage distribution network.

b) In addition to option a) ensure the structure of the new section mirrors that in section 3.6 of the proposed Technical Rules (discussed in section 6.4 of this submission) with changes to subsections and clauses made to express appropriate requirements for low voltage connected generating systems.

c) Option b) with the requirements for inverter energy systems connected via a standard connection service moved to a separate section within Chapter 3.

Option c) is preferred as this approach provides a structure that clearly distinguishes requirements for:

- Small generating systems connected to the **high** voltage distribution system,
- Small generating systems connected to the **low** voltage distribution system, and
- Inverter energy systems connect to the low voltage distribution system.

The new structure allows for technical requirements to be varied between these different voltages and systems as appropriated.

The recommended option is implemented through the following new clauses added to sections 3.6 and 3.7. The revised section 3.7 specifies the requirements that Users must meet for small generating systems (aggregate rated capacity ≤ 5 MVA) connected to the low voltage distribution system. The requirements in this section have been developed by implementing a series of revisions to the requirements specified in section 3.6 of the Technical Rules to customise requirements to suit connection to the low voltage distribution system. Consequently, the structure of section 3.7 and 3.6 in the revised Technical Rules are aligned. Alignment of the two sections will simply navigation of technical requirements, particularly for Users who operate generating systems connected to the high voltage and low voltage distribution systems.

The key changes made between the clauses in section 3.6 and 3.7 include:

- Clause 3.7.1 of the proposed Technical Rules provides an overview of section 3.7 and states that the section present requirements for small generating systems connected to the low voltage distribution network. Drafting in this clause clarifies that the requirements for inverter energy systems connected the low voltage distribution network via a standards connection service are specified in section 3.8.
- Clause 3.7.2(c) of the proposed Technical Rules includes the same provision that appears as clause 2.6.2(c)(3) in the current Technical Rules. This clause allows Users to elect to have their facility assessed for compliance against the requirements for a connection to the high voltage distribution system.
- Various clauses of the proposed Technical Rules recognise that a sufficient technical requirement for the generating systems connected via inverters is that the inverters comply with the relevant Australian Standard AS/NZS 4777.2. For example, this is reflected in clause 3.7.5(a) of the proposed Technical Rules.
- Adjustment of wording throughout section 3.7 to only refer to connection to the distribution system not the transmission and distribution systems
- Adjustment to the power quality and voltage change requirements to allow the Network Service Provider to permit a voltage step changes of up to 5% on low voltage feeders in some circumstances.

Western Power considers that the recommended option will deliver benefits to Users seeking to develop a small generating system connected to the low voltage distribution system because:

- The clarified technical requirements are presented in a manner that is very similar to that adopted for high voltage connected small generating systems enabling consistent navigation by Users.
- The technical requirements implement appropriate refinements allow Users to leverage the capability available in inverters that are compliant with AS/NZS 4777.2 to reduce connection costs.

6.5.2 Export and generation limit controls

Current issue

Western Power is looking to assist with the decarbonisation of the energy supply on its network. To do this all sources of electricity supply need to be controlled and managed. During certain times of the day the maximum load on the power system will be over catered for compared with the levels of rooftop PV on the system. The distributed generation from Users on the low voltage distribution system needs to work in conjunction with centralised generation for the power system to be operated reliably and within performance requirements in Chapter 2 of the Technical Rules.

Without other incentives, low voltage distribution consumers are expected to install more generation from a variety of sources (e.g., rooftop PV systems, batteries, electrical vehicles) than their electrical installation (i.e., switchboard) is rated for. This trend represents an increasing risk for consumers as the size of systems and number of systems increase.[55] The implementation of export and generation limits would allow for the control of generation such that low voltage customer's energy usage requirements can be met through embedded generation systems with adequate controls in place for the Network Service Provider to meet obligations for all Users connecting to the power system.

In small systems:

- generation limits control the amount of apparent power that may flow from the small generating system (including an inverter energy system) towards the rest of the electrical system behind the connection point.
- Export limits are limits on the export of active power from the Users installation (as a net amount) to the rest of the network and is measured at the connection point.

The above definitions leverage the terminology used in section 6 of AS/NZS 4777.2 and are appropriate for a Technical Rules context. It is noted that for larger systems, generation limits are measured in terms of active power. However, for smaller systems covered in the sections 3.7 and 3.8 of the proposed Technical Rules the appropriate measure is apparent power (i.e., the rating of equipment rather than the power flow).

The current Technical Rules are silent and limited in terms of the management of these growing connections and connection types. The ability to apply generation and export limits and accept them under the Rules is required to allow this innovation and customer choice to occur.

Solution options & preferred solution

Western Power considered the following options to address this issue:

a) Include new clauses in sections 3.7 and 3.8 (the introduction of which is discussed in section 6.6 of this submission) that enable the Network Service Provider to specify generation and export limits.

b) In addition to option a), allow for the adjust the generation and export limits over time if required as the power system evolves.

c) No change.

Option b) is preferred as it will enable a managed approach to the increasing numbers and diverse range of small systems on the low voltage distribution system. The changes also set the industry up for the successful future implementation of dynamic import and export levels at where virtual power plants and aggregators need to operate. The inclusion of a revision provision is preferred to a static approach that risks introducing unbalanced approaches to manage power system challenges (and safety) as the system continues to involve. The additional cost of these systems is likely to be minimal when they are included as part of the original generation installation, whereas alteration that occurs after initial installation is likely to incur a higher cost and comes with a risk that equipment needed is unavailable or obsolete (rather involving simple software changes at initial installation). Inclusion of the requirements at the initial

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55 As installations become cheaper and larger the likelihood of customer installing systems that exceed their switchboard ratings increases. Exceedance of switchboard ratings is potentially dangerous as the equipment

installation point also prepares the generator for potential future participation in aggregation platforms that control generation at low voltage levels.

No change is not considered an appropriate option. Without a mechanism to manage and enable increased small generation on the low voltage distribution system uncontrolled generation will exceed load on the network, risks from which can only be managed by not allowing connections to proceed.

6.5.3 Remote monitoring and control

Current issue

The current Technical Rules do not adequately provide for visibility over or control over small generating systems on the low voltage distribution system. While there remains no mechanism in the Technical Rules to introduce critical remote monitoring and control for these installations, the network is effectively managed 'blind'.

As the number and range of installations increases, having the ability to improve the visibility and control small generating systems is important for power system management. As highlighted in section 6.5.2 of this submission, the level of distributed generation (including rooftop PV, batteries and electric vehicles) is expected to exceed the amount of generation required during low demand periods in the future. However, distributed generation needs to work in conjunction with centralised generation for the power system to be operated reliably.

The remote monitoring and control being considered includes enabling:

- Signals from the small generating system installation through third parties (e.g. aggregators and retailers) to the Distribution Network Operator (and any future Distribution System Operator) or, in some cases, for the DNO to receive information directly from the installation (rather than via third party) for protection and islanding, for example.
- Commands sent from the DNO to the installation (via third party or direct). This may include commands related to the generation and export control. It may enable future commands needed for a Distribution System Operator such as setting changes.

Solution options & preferred solution

Western Power considered the following options to address this issue:

a) Include new clauses in sections 3.7 and 3.8 (the introduction of which is discussed in section 6.6 of this submission) that enable the Network Service Provider to remote monitoring and control requirements.

b) In addition to option a), allow for the adjust the remote monitoring and control requirements over time if required as the power system evolves.

c) No change.

Option b) is preferred as it will enable a managed approach to the increasing numbers and diverse range of small systems on the low voltage distribution system. Providing better visibility as to the load and generation on the system is needed to enable management and control. This is particularly important for load and generation systems behind a single connection point where the Distribution Network Operator (and any future Distribution System Operator) is seeking to avoid unintended consequences from broader commands (e.g., gaining more load than expected when managing generation to stabilise the network due to export being the only part of generation being visible to the grid). Similar to the proposed changes that enable export and generation limits, the costs to small customers is likely to be minimal if the requirements are catered for at the point of initial installation.

The remote monitoring and control provisions are also enablers for the export and generation limit control discussed in section 6.5.2 of this submission. The information assists the Network Service Provider in establishing the limits where appropriate and enables monitoring of compliance with limits.

6.5.4 Reconfirmation of correct operation

As outlined in section 6.5.4 of this submission, the current Technical Rules allows for the Network Service Provider to inspect the small generating installations and to disconnect the generating equipment if the Network Service Provider considers that the installation poses a threat to safety, to quality of supply or to the integrity of the distribution system.

The provisions that apply to small generators to be covered by section 3.7 of the proposed Technical Rules are located in various sections of the existing Technical Rules, do not allow the Network Service Provider to request changes to address issues other than disconnection and the requirement to demonstrate the threat of an individual unit to safety , quality of supply or the integrity of the distribution system is inappropriately onerous as the number of small systems on the power system increases.

The options considered for reforms and the preferred solution are the same as those set out in section 6.5.4 of this submission. As stated in section 6.5.4 of this submission, the changes provide better clarity on the existing provisions for small generators covered by sections 3.6 and 3.7 of the proposed Technical Rules. There is a more suitable range of options available to the Network Service Provider in managing potential issues associated with or optimally managed through changes to all small generators (including those covered in proposed sections 3.6, 3.7 and 3.8). Further, the updated drafting makes the obligation on the User or Generator on remaining compliant with the Technical Rules are clearer.

6.6 Inverter energy systems connected to the low voltage distribution system via a standard connection service

Section 3.7 in the current Technical Rules specifies the requirements for inverter energy systems connected to the low voltage distribution system. As discussed in the section 6.5 of this submission, there are several reasons why it is appropriate to separate the requirements for small generation and energy systems on the low voltage distribution system from those on the high voltage distribution system. In addition to this distinction, there are Australian Standards that apply specifically to small inverter connected energy systems connected to the low voltage distribution system. Western Power has also developed (and already uses) a standard connection arrangement that applies to a large number of these installations, which offers a streamlined approach to these smaller connections.

Current issue

The current Technical Rules do not consistently appropriately leverage the capability provided by inverters that comply with AS/NZS 4777.2. Recognising that capability has the potential to clarify the specification of technical requirements and reduce compliance costs for Users.

The current drafting also includes some detailed information, such as schematic diagrams and metering information, that is inconsistent with the level of detail provided in the remainder of the Technical Rules and is better provided through the connection standards maintained by Western Power. Moving this information from the Technical Rules to a connection standard is consistent with contemporary practice as recommended by the Electricity Network Association and implemented by distribution network service providers operating in the NEM and by Horizon Power.

Finally, the current Technical Rules could more clearly distinguish the requirements for inverter energy systems connected to the low voltage distribution system via a standard connection arrangement by separating these requirements from other connection that do not use the standard connection arrangement.

Solution options & preferred solution

Western Power considered the following options to address the above issues:

a) Introduce a new section 3.8 to identify the requirements for inverter energy system connected via a standard connection service.

b) In addition to option a) remove information that is best specified via a connection standard maintained by the Network Service Provider.

c) In addition to option b) implement revisions to clauses that recognise the capability that is provided by inverters that comply with AS/NZS 4777.2.

Option c) is preferred as this approach addresses all the identified concerns.

The recommended option is implemented by translating the requirements expressed in section 3.7 of the current Technical Rules into a new set of requirements in section 3.8 of the proposed Technical Rules. Figure 6-2 compares the structure of the existing section 3.7 and the new section 3.8.

Figure 6-2: Overview of inverter energy system requirements specified in section 3.8

Structure of section 3.7 in the current Technical Rules:
3.7.1 Scope
3.7.2 Energy System Capacity, Imbalance and Assessment
3.7.3 Relevant Standards
3.7.4 Metering Installation
3.7.5 Safety
3.7.6 Circuit Arrangements
3.7.7 Protection
3.7.8 Commissioning and Testing
3.7.9 Signage

Proposed structure for section 3.8 - Requirements for the connection of inverter energy systems to the low voltage distribution system via a standard connection service:
3.8.1 Overview
3.8.2 Energy system capacity, imbalance and assessment
3.8.3 Relevant standards
3.8.4 Safety
3.8.5 Connection and operation
3.8.6 Remote control and operation
3.8.7 Commissioning and testing

The key changes made between the clauses in the existing section 3.7 and the new section 3.8 include:

- Information that is better expressed in the relevant connection standard have been removed from the Technical Rules. This has resulted in the removal of:
  - Metering requirements that currently appear as clause 3.7.4 in the current Technical Rules,
  - Requirements for labelling of switches currently specified in clause 3.7.5.1, and
  - Requirements specified in section 3.7.6 of the current Technical Rules with only main switch requirements retained in the new section 3.8.
- The requirement for inverters to comply with AS/NZS 4777.2 has been added to clause 3.8.1(d) and the requirements in section 3.8.3 specifying relevant standards clarified.
- As discussed in section 6.8.1 of this submission, protections requirements have been moved to section 3.5 and consolidated with other User protection requirements.
- Adding a requirement that the Network Service Provider's approval be sought before changing parameters on an installed inverter energy system and including a requirement for the User to audit settings if requested to do so by the Network Service Provider.
- Adding specific requirements to provide for export limit control, generation limit control and including provisions that require the User to provide remote control of the inverter energy system if requested to do so by the Network Service Provider. These additional requirements are all achievable by inverters that comply with AS/NZS 4777.2. That rational for this is the same as that provided for small generators connected to the low voltage network set out in sections 6.5.2 and 6.5.3 of this submission.
- Clarifying the provisions that allow the Network Service Provider to confirm compliance with the Technical Rules and request information if required. Drafting of these provisions have also been updated to:
  - align with drafting introduced for other small generators (refer to sections 6.4.5 and 6.5.4 of this submission for issues and rational for changes affecting all small generators), and
  - allow the Network Service Provider to request setting changes and for the User to the implement the setting changes on installations, which provides a lesser measure than the existing provisions that only consider the disconnection of the installation.

Western Power considers that the recommended option delivers benefits to Users seeking to connect inverter energy systems via a standard connection service because:

- The clarified technical requirements align with contemporary practice.
- The technical requirements implement appropriate refinements allow Users to leverage the capability available in inverters that are compliant with AS/NZS 4777.2 to reduce connection costs.

6.7 Loads

Section 3.4 of the Technical Rules specify the technical requirements than must be met by facilities that consume electrical power (i.e., loads). Western Power did not identify a need to restructure this section of the Technical Rules and proposed the following key revisions:

- Changes that support the consolidation of all User protection requirements in section 3.5 of the proposed Technical Rules.
- Insert clarifications that where a User's facility includes both load and generation, the User should ensure that load shedding facilities provided by the User only disconnect loads and not generation at the site.

The rational for each of the key revisions are presented in the subsequent sections.

6.7.1 Protection requirements

As noted in section 6.8.1 of this submission, Western Power recommends consolidating the User protection requirements in section 3.5 of the Technical Rules to address issues identified with the existing fragmented definition of User protection requirements. To support this change, a change to clause 3.4.1 is proposed to include a new clause identifying the sub-clauses within the revised section 3.5 that are applicable to consumers (3.4.1 (c) of the proposed Technical Rules).

6.7.2 Load shedding facilities

The Technical Rules currently contain provisions requiring consumers to provide their loads to be shed to help prevent frequency collapse following non-credible contingency events.

Current issue

It is increasingly common for User facilities to contain a mix of loads and generation (including energy storage facilities) behind a single connection point. It is important that in response to underfrequency events loads are tripped and not generation or embedded electricity storage (when discharging active power). However, there is no provision in the Technical Rules that specifies this requirement.

Solution options & preferred solution

Western Power proposes adding a new clause (3.4.9.1(b) of the proposed Technical Rules) to clarify that under frequency load shedding facilities provided by a consumer should result in a net reduction in active power at the connection point.

A second new clause (3.4.9.1(c) of the proposed Technical Rules) that makes existing obligations on Users clearer. This clause requires Users not to exceed any export limits or to disconnect following a load shedding event until frequency returns to normal where not export limit exists.

6.8 User protection

This section presents the review of the User Protection requirements within the Western Power Technical Rules. The principal focus area is section 3.5, which covers obligations on Users related to protection. However, work on section 3.5 of Technical Rules was considered in conjunction with section 2.9, which covers Transmission and Distribution System Protection (refer to Chapter 5 of this submission).

The structure of section 3.5 of the Technical Rules is illustrated in Figure 6-3, which compares the structure in the current Technical Rules and the revised structure proposed by Western Power.

Figure 6-3: Overview of User Protection Requirements

Structure of section 3.5 in the current Technical Rules:
3.5.1 Overview
3.5.2 Specific Protection Requirements for Generator Facilities
3.5.3 Specific Protection Requirements for Consumer Facilities

Proposed structure for section 3.5 - User's protection requirements:
3.5.1 Overview
3.5.2 Protection requirements for transmission connected generating systems
3.5.3 Protection requirements for distribution connected generating systems
3.5.4 Protection requirements for small generating systems connected via a standard connection service
3.5.5 Protection requirements for loads

The key revisions proposed for the User protection requirements include:

- Restructuring the User protection requirements to consolidate all requirements into relevant clauses within section 3.5, which efficiently identify applicable protection requirements for different types of facilities.
- Recognising the need to cooperate on protection system design and implementation.
- Clarifying the need to seek Network Service Provider approval for changes to User protection systems.
- Clarifying the scope of protection requirements specified for large generating systems.
- Clarifying acceptable anti-islanding protection arrangements for transmission connected large generating systems.
- Aligning protection and disturbance ride-through requirements.
- Relaxing location of protection function for small generating systems connected to the low voltage distribution system.
- Allowing distribution connected generators to utilise back-up protection provided by protection functions implemented in AS NZ 4777 compliant inverter.
- Allowing distribution connected generators connected via AS NZ 4777 compliant inverters to utilise earth-fault protections integrated withing an anti-islanding scheme.
- Clarifying anti-islanding protection requirements for distribution connected generating systems,
- Clarify protection requirements for consumer facilities.

The rational for each of the key revisions are presented in the subsequent sections, a key focus of the revisions to the protection requirements has been to improve clarity for Users and to incorporate appropriate relaxation and qualifications into the requirements to help Users reduce costs while not compromising power system security.

6.8.1 Revised Structure

Current Issue

The existing organisation of chapter 3 of the Technical Rules has protection obligations appearing in section 3.5 and additional protections requirements distributed across other subsections of chapter 3. This approach makes it difficult for a User to identify the protection requirements that apply to their facility. Continuing this approach with the introduction of new sub-sections into chapter 3 to clarify requirements for all types of generating systems also creates the risk of inadvertent inconsistency between protection requirements for generators connecting to the same network voltage level.

Solution options & preferred solution

Western Power considered the following solutions to address this issue:

a) Revise chapter 3 with all User protection requirements consolidated in section 3.5

b) In addition to a) include clauses in the overview section of each subsection of chapter 3 providing technical requirements for different types of User facilities, that identify the relevant clauses in section 3.5 that apply to the type of User facility

c) In addition to b) adopt a structure within clause 3.5 that avoids unnecessary repetition of protection requirements for User facilities connected to the same network voltage level.

d) No change continue with protection requirements distributed across chapter 3.5

Option c) is preferred as it provides for more efficient specification of protection requirements, assists Users to identify the requirements applicable to their facilities and reduces the risk of inadvertently specifying inconsistent protection requirements for Users connected as the same voltage level.

The key revisions to the proposed Technical Rules made to implement the recommended option are:

- Adopt the high level structure shown in Figure 6-3 for section 3.5
- Add appropriate clauses to the overview sections of sections 3.3, 3.4, 3.6, 3.7 and 3.8 specifying which clauses in section 3.5 apply
- Add clauses in each of sections 3.5.2, 2.5.3, 3.5.4 and 3.5.5 that restate which classes of facilities must adhere to the protection requirements specified in each section.
- remove clause 3.6.10. 3.6.11 and 3.6.12 in revisions 3 of the Technical Rules, replacing that clause by equivalent provisions in clause 3.5.3 of the revised Technical Rules.
- remove protection requirements in clause 3.7.7 in revisions 3 of the Technical Rules, replacing that clause by equivalent provisions in clause 3.5.4 of the revised Technical Rules.

6.8.2 Approval for changes to User protection systems

Current issue

Sub-clause 3.5.1(h) states that a “consumer” must not adjust its protection settings without the Network Service Provider’s approval. However, the rest of clause 3.5.1 refers to “user”. The terms “Consumer” and “User” are defined as per Table 6-1 (below) in the Technical Rules. The requirements in clause 3.5.1(h) should apply to all Users not just consumers.

Table 6-1 Relevant consumer and user definitions in the Technical Rules

Term	Current definition
Consumer	A *User* who consumes electricity supplied through a *connection point*.
User	Has the meaning given in clause 1.3(b)(3) [of these Technical Rules]. 1.3(b)(3) of the Technical Rules is replicated below: *Users* of the *transmission or distribution system* who, for the purposes of these *Rules* include: (A) every person who seeks access to *spare capacity* or *new capacity* on the *transmission or distribution system* or makes an *access application* under the *Access Code* in order to establish a *connection point* or modify an existing *connection*; (B) every person to whom access to *transmission* and *distribution* capacity is made available (including every person with whom the *Network Service Provider* has entered into an *access contract* or *connection agreement*).

Additionally, while the existing clause may prohibit a user from adjusting their protection settings without approval of the Network Service Provider, it does not explicitly prohibit other potential modifications without notifying the Network Service Provider, such as modification of a protection scheme or replacement equipment. Unapproved changes to protection systems should be avoided to ensure appropriate coordination of any changes to User protection systems within Network Service Provider protection systems.

Solution options

Western Power considered the following options to address the above issues:

a) Amend clause 3.5.1(h) to address the terminology issue outlined i.e. correct the use of the term 'consumer', and augment the wording of the clause to include provisions requiring approval for all modifications of protection schemes or equipment.

Leave the clause unchanged.

Western Power recommends changes consistent with option a). The current terminology issue should be addressed. Further, updating clause 3.5.1 of the Technical Rules to include provision for seeking the Network Service Provider's approval before a user modifies any protection systems or equipment, in addition to the modification of protection settings, is considered appropriate given the need to coordinate protection scheme functionality between the User and the Network Service Provider.

6.8.3 Cooperative design of protection systems

Clause 3.5.1(d) of the Technical Rules requires a User and the Network Service Provider to cooperate on specified aspects of the design and implementation of protection systems. With the aspects requiring coordination listed in the clause.

Current Issue

Protection systems are often implemented to enable a User connection to proceed while avoiding or deferring the need for network augmentations. Clause 3.5.1(d) currently does not explicitly require coordination of the functionality of protection systems including generator runback schemes and other special protection schemes, which may lead to confusion over the need to coordinate their design.

Solution options & preferred solution

Western Power considered the following solutions to address this issue:

a) Revise clause 3.5.1(d) to include a specific provision requiring the coordination of the functionality of protection systems required as a condition of the User's connection to the transmission or distribution system

b) No change to the existing wording

Option a) is preferred as it provides greater clarity for Users regarding the need to coordinate the functionality of all protection systems which included and special protection system.

6.8.4 Clarify scope of protection requirements for large generating systems

Current issue

Clause 3.5.2(b) in the current Technical Rules states that the protection systems for a generating unit must be designed to protect the generating unit. This wording indicates that the large generating system protection requirement may exceed the scope specified in clause 3.5.1(a) which states that the requirements in clause 3.5 are limited to the User's protection system requirements that are necessary to maintain power system security and not protection systems installed to cover risks to the User's equipment.

The inconsistency between the two clauses should be addressed to avoid potential confusion.

Solution options

Western Power considered the following options to address the above issue:

a) Amend sub-clause 3.5.2(b) to remove the statement which could be interpreted as extending the scope to all protection systems necessary to protect the generating system.

Leave clause unchanged.

Western Power recommends changes to the Technical Rules consistent with option a). This will prevent any confusion regarding the scope of protection requirements specified in the Technical Rules.

6.8.5 Acceptable anti-islanding for transmission connected generating systems

Anti-islanding protection is also referred to a loss of mains or loss of supply protection. It is designed to ensure that a generating system is prevented from supplying an isolated portion of the power system when it is not appropriate to do so.

Current Issue

Clause 3.5.2(d)(2) in the current Technical Rules details that a generator's generating unit must be disconnected from the transmission and distribution system if there is a loss of supply to the User's installation. The current wording does not specify the type of loss of mains protection scheme to be used (i.e. Rate of Change of Frequency, vector shift, etc), hence the requirement is open to interpretation. There are differing technical characteristics associated with each type of loss of mains or anti-islanding scheme. The existing wording leave open to interpretation which schemes are acceptable and for the avoidance of doubt it would be better to state what scheme type(s) is preferred by Western Power to remove the ambiguity.

Western Power notes that clause 3.6.10.3 in the current Technical Rules details acceptable methods of loss of mains detection that apply at distribution voltages. A cross reference to these methods is recommended for clarity.

Western Power notes that clause A12.13.3.3 of the WEM Rules specifies requirements for transmission connected generating systems that participate in the WEM to install appropriate anti-islanding systems. The WEM Rules require the details regarding the performance of the anti-islanding systems to be documents in accordance with guidelines produced by the Network Operator. The anti-islanding requirements in the Technical Rules should be consistent with the requirements in the WEM Rules.

Solution Options

Western Power considered the following options to address the above issues:

a) Provide additional details in clause 3.5.2 specifying acceptable anti-islanding schemes

b) Revise clause 3.5.2 to include:

    i) a requirement for an appropriate anti-islanding scheme which is consistent with guidelines produced by the Network Service Provider, and

    ii) a requirement for the Network Service Provider to develop the anti-islanding guideline for large generating systems connected to the transmission system

c) Leave the clause unchanged.

Western Power recommends amendments to the Technical Rules consistent with option b). This is the preferred solution as it maintains consistency with the requirements defined in the WEM Rules and delivers the required additional clarity regarding the appropriate anti-islanding requirements.

6.8.6 Aligning protection and disturbance ride-through requirements

Clause 3.3.7.7, 3.3.7.8 and 3.3.7.9 in the revised Technical Rules introduce various generator performance standards that require large generating systems to ride-through disturbances. It is important that protection systems on large generating systems do not have settings which will prevent the generating system from meeting the disturbance ride through requirements.

Current Issue

The existing protection provisions in the Technical Rules for large generating systems, do not include clauses which specify that generating system protection systems and settings should be set to enable the disturbance ride through requirements to be achieved. The absence of a clause specifying this requirement risks misalignment between the disturbance ride through requirements and the User protection requirements.

Clause A12.13.3.4 in the WEM Rules specifies that transmission connected generating systems participating in the WEM must include protection schemes:

- necessary to disconnect the generating system during abnormal conditions in the power system that would threaten the stability of the generating system, or risk damage to the generating system, and
- that enable the disturbance ride through generator performance standards to be achieved.

The existing generating system protection requirements in the Technical Rules are therefore not aligned with those in the WEM Rules.

Solution Options

Western Power considered the following options to address the above issues:

a) Provide an additional clause in section 3.5.2 reflecting the drafting in WEM Rules clause A12.13.3.4. This aligns the protection requirements in the Technical Rules for transmission connected generating systems with those in the WEM Rules for transmission connected generating systems participating in the WEM.

b) In addition to a) include a similar clause in section 3.5.3.2 to ensure a similar requirement is specified for large generating systems connected to the high voltage distribution network

c) Leave the clauses unchanged.

Western Power recommends amendments to the Technical Rules consistent with option b). This is the preferred solution as it maintains consistency with the requirements defined in the WEM Rules and delivers consistency between the generating system protection requirements and the disturbance ride-through requirements in the generator performance standards.

6.8.7 Relaxing location of protection function for small generating systems connected to the distribution system

Clause 3.6.10.1(a) in the current Technical Rules requires that protection functions for generating systems connected to the distribution system respond to quantities measured at the connection point.

Current Issue

This requirement can result in additional expense for generating systems that connect to the low voltage distribution network that do not have monitoring equipment available at the connection point. This particular requirement has been the subject of over 60 exemption requests and Western Power has allowed the use of quantities measured at other locations provided that doing so would not reduce the ability to maintain power system security.

Solution Options

To reduce the need for future exemptions and reduce the cost faced by Users connecting small inverter connected generating systems to the low voltage distribution system, Western Power recommends revising the corresponding clause in section 3.5.3 of the proposed Technical Rules.

In the proposed Technical Rules, clause 3.5.3.2(b) states:

> *For a generating system with an aggregate rated capacity less than or equal to 1 MVA and comprised of inverter connected generating units, the Network Service Provide may accept protection functions that respond to quantities measured at other locations within the Users facility provided these protection arrangements:*
>
> *(1) are consistent with any guidelines developed by the Network Service Provider, and*
>
> *(2) do not reduce the ability to maintain power system security.*

The proposed change allows relaxation of the measurement location for the quantities used in the generating system protection functions to be varied where this does not impact power system security.

6.8.8 Back-up protection provided by inverter protection functions

Clause 3.6.10.1(d) in the current Technical Rules requires that protection systems for generating systems connected to the distribution system provide sufficient back-up protection to cover for the failure of any one protection device.

Current Issue

This requirement has been the sources of a significant number of exemption request from Users seeking to connect generating systems via inverters compliant with the latest Australian Standard. Users have sought, and in many cases, been granted exemptions (> 550 exemptions granted). The exemptions recognise that the protection functions provided by inverters complying with AS/NZS 4777.2 are suitable options for the back-up protection. In addition, technology changes have enabled a wider range of protection solutions, including the use of protection integrated in AS/NZS 4777 compliance inverters.

Solution Options

To reduce the need for future exemptions and reduce the cost faced by Users connecting small inverter connected generating systems to the low voltage distribution system, Western Power recommends revising the corresponding clause in section 3.5.3 of the proposed Technical Rules.

In the proposed Technical Rules, clause 3.5.3.2(j) is updated to state:

> *All power stations that have an export limit shall have directional (export) power or directional current limits set appropriate to the export limit. For inverter connected generators that conform with AS/NZS 4777.2, in certain circumstances, the integrated export limit control set to the appropriate export limit may be used in place of an external protection relay. The Network Service Provider must advise the Generator of the conditions to be satisfied for the Network Service Provider to accept the export limit control in the inverters.*

Clause 3.5.3.2(f) states:

> *All dedicated protection apparatus must comply with the IEC 60255 series of standards. Integrated control and protection apparatus may be used provided that it can be demonstrated that the protection functions are functionally independent of the control functions, i.e. failure or mal-operation of the control features will not impair operation of the protection system.*

And a note appearing after clause 3.5.3.2(e) states:

Note: This may be achieved by providing back-up *protection schemes* (including *protection* functions implemented in AS/NZS 4777.2 compliant inverters) or designing the *protection system* to be fail-safe, e.g., to trip on failure.

The proposed change allows back-up protection to utilise the protection functions provided by the AS/NZS 4777.2 compliant inverters.

6.8.9 Combined earth fault and anti-islanding protection

Clause 3.6.10.1(g) in the current Technical Rules requires that:

- protection systems for generating systems connected to the distribution system provide earth fault protection for earth faults on the distribution systems, and
- generating systems connected to the high voltage distribution systems have a sensitive earth fault protection scheme.

Current Issue

The clause 3.6.10(g) requirements have been the source of a significant number of exemption requests from Users seeking to connect generating systems via inverters compliant with the latest Australian Standard. Users have sought, and in many cases been granted, exemptions (> 600 exemptions granted) recognising that for these generating systems the earth fault protection can be integrated with an anti-islanding scheme.

Sensitive earth fault requirements are relevant to loads.[56] However, in the current Technical Rules these requirements have been included in section 3.6, which is applicable to generators only.

Solution Options

To reduce the need for future exemptions and reduce the cost faced by Users connecting small inverter connected generating systems to the low voltage distribution system, Western Power recommends revising the corresponding clause in section 3.5.3 of the proposed Technical Rules.

In the proposed Technical Rules clause 3.5.3.2(h) and the note following it state:

> *All power stations must provide earth fault protection for earth faults on the distribution system.*

> **Note:**
> The earth fault *protection scheme* may be earth fault or neutral *voltage* displacement (depending on the earthing system arrangement). For *generating systems* with an aggregate rated capacity of less than or equal to 1 MVA and *connected* via *inverters*, the earth fault *protection* may be integrated within an anti-islanding scheme.

The sensitive earth fault requirements are now appropriately located under the load section within section 3.5 of the proposed Technical Rules.

6.8.10 Anti-islanding protection requirements for distribution connected generating systems

Clause 3.6.10.3 in the current Technical Rules specifies the anti-islanding protection requirements for distribution connected generating systems. The clause requires two different functional types of anti-islanding protection be provided. In addition, generating systems with a rated capacity above 1 MVA are required to have each functional type of anti-islanding protection incorporated in a physically separate protection relay.

Current Issue

As currently drafted, clause 3.6.10.3 of the Technical Rules does not acknowledge the potential to utilise the anti-islanding protection incorporated in inverters to reduce the cost of meeting anti-islanding requirements. Inverters compliant with the AS/NZS 4777.2 incorporate anti-islanding protection functions that can be utilised in many situations to help reduce the cost of provided anti-islanding protection while maintaining a sufficiently reliable protection scheme to mitigate any system security or safety risk.

Solution Options

To reduce the cost to Users of providing anti-islanding protection while providing sufficiently reliable anti-islanding protection to maintain power system security and safety, Western Power has proposed revisions to the anti-islanding requirements for distribution connected generating systems.

The revised requirements are implemented in clauses 3.5.3.4(b) through (e) of the proposed Technical Rules. The revised requirements allow the following potential relaxation of the anti-islanding requirements:

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56 Sensitive earth fault is a form of earth fault protection that is set to be highly sensitive to detect fallen overhead conductors that may not produce a lot of fault current.

- For generating systems with an aggregate capacity of ≤1 MVA that are connected to the low voltage distribution network via inverters that comply with AS/NZ 4777.2, the Network Service Provider may accept the anti-island protection incorporated within the inverters as sufficient.
- For generating systems with an aggregate capacity of ≤1 MVA that are connected to the high voltage distribution network via inverters that comply with AS/NZ 4777.2, the Network Service Provider may accept the anti-island protection incorporated within the inverters providing one of the anti-islanding protection functions provided the other function is provided by an IEC 60255 compliant external generator protection relay.

6.8.11 Protection requirements for loads

Current Issue

Clause 3.5.3 in the current Technical Rules uses the term “total fault clearance time” rather than “maximum total fault clearance time” as per other clauses (3.5.2(b) and 2.9.4). This should be amended for consistency.

Clause 3.5.3 does not include any requirement for loads connected to the high voltage distribution system to provide a sensitive earth fault protection scheme. Western Power may require this protection for high voltage connections to ensure appropriate detection and clearing of high impedance faults within the facility. This requirement has been located in section 3.6 of the current Technical Rules, which deals only with generation (while the requirement is relevant to loads).

Solution Options

Western Power recommends making the following changes to the consumer protection requirements specified in clause 3.5.5 in the proposed Technical Rules to address the above issues:

a) Amend sub-clause 3.5.5(a) replacing the phase total fault clearance time with maximum total fault clearance time accordingly.

b) Add a new clause 3.5.5(c) specifying the requirement for sensitive earth fault protection for facilities connected to the high voltage distribution system.

Implementing these changes will clarify the protection requirements for consumer facilities in the Technical Rules.

7. Inspection, testing, commissioning and decommissioning

The inspection, commissioning and testing requirements that apply to Users connecting to Western Power's networks are outlined in chapter 4 of the Technical Rules.

The structure of this chapter of the Technical Rules is illustrated in the following diagram.

4.1 – Inspection and Testing
4.2 – Commissioning of User's Equipment
4.3 – Disconnection and Reconnection

4.1 – Inspection and Testing
- 4.1.1/2 – Right of Entry and Inspection / Testing
- 4.1.3 – Tests to Demonstrate Compliance with Connection Requirements for Generators
- 4.1.4 – Routine Testing of Protection Equipment
- 4.1.5 – Testing by Users of their own Equipment Requiring Changes to Agreed Operation
- 4.1.6 – Tests of Generating units Requiring Changes to Agreed Operation
- 4.1.7 – Power System Tests

4.2 – Commissioning of User's Equipment
- 4.2.1 – Requirement to Inspect and Test Equipment
- 4.2.2 – Co-ordination during Commissioning
- 4.2.3 – Control and Protection Settings for Equipment
- 4.2.4/5 – Commissioning Program / Tests
- 4.2.6/7 – Co-ordination of Protection Settings / Approval of Proposed Protection

4.3 – Disconnection and Reconnection
- 4.3.1 – General
- 4.3.2/4 – Voluntary / Involuntary Disconnection
- 4.3.3 – Decommissioning Procedures
- 4.2.5 – Curtailment to Undertake Works
- 4.2.6 – Disconnection During and Emergency
- 4.3.7 – Obligation to Reconnect

The limitations, issues and proposed solutions to address issues that have been identified through the Technical Rules review process are discussed in the sub-sections that follow.

7.1 Right of Entry and Inspection

Clause 4.1.1 of the Technical Rules outlines why Users, System Management or Network Service Providers can undertake inspections of equipment connected to the network. The current drafting allows the Network Service Provider, System Management and any User (or their representative) whose equipment is connected to the transmission system with appropriate notice to enter and inspect any of the Network Service Provider's or any other User's facility.

The Network Service Provider and System Management (now AEMO) require this privilege to inspect facilities to:

- ensure the facility owner is complying with its obligations, the Technical Rules, and any relevant connection agreement,
- investigate any operating incidents,

- investigate any potential threat by that facility to power system security, and
- conduct training associated with that facility.

7.1.1 Current issue

Clause 4.1.1(a) of the Technical Rules states that Users have the same rights as the Network Service Provider and System Management to inspect facilities owned by other Users and the Network Service Provider. While it is reasonable for the Network Service Provider and System Management (now AEMO) to possess this right, the rationale for allowing other Users to possess the right to enter and inspect other User's or the Network Service Provider's facilities is not clear.

As the clause is currently drafted, there is potential for misuse of the right of entry and inspection powers where Users are concerned, and there is no provision to refuse these rights.

Clauses 4.1.1(d), (e), (f) and (h) seek to limit the rights of the inspector by:

- requiring adequate notice be given to facility owner being inspected,
- limiting the regularity of the inspections to once every six months except in cases of non-conformance and by the Network Service Provider and System Management where investigation of operating instances under clause 5.7.3 of the Technical Rules is concerned,
- limiting the actions that can be taken during the inspection, and
- limiting the duration of the inspection to one day unless otherwise approved by the owner of the facility being inspected.

However, these clauses only mitigate and do not eliminate the risks associated with giving all Users the right to enter and inspect other's facilities.

7.1.2 Solution options & preferred solution

Western Power considered the following options that would address this issue:

a) Revising clause 4.1.1 of the Technical Rules to limit the right to inspect to the Network Service Provider. This involves redrafting the clause to remove explicit mention of User's and System Management's right to enter and inspect. While Western Power considers AEMO, in its role as System Management, should have the right of entry and inspection as currently drafted, AEMO's rights are detailed in the WEM Rules. The provisions under this option would be updated to require the Network Service Provider to share any collected information with AEMO, as appropriate.

b) Revising clause 4.1.1 of the Technical Rules to limit the right to inspect to Network Service Provider and AEMO. This involves redrafting the clause to remove explicit mention of the User's right to enter and inspect.

c) No change.

Option b) is preferred as it clarifies the scope of the right to the required parties (the Network Service Provider and its representatives). It also reflects AEMO's rights under the WEM Rules but is clearer than option a), whereby AEMO is omitted from the clauses. This option appropriately allows the Network Service Provider to perform inspections as required to perform its role under the Technical Rules, maintains AEMO's rights under the WEM Rules, and removes the potential for Users to use the right to enter and inspect inappropriately.

7.2 Testing by qualified persons

Testing by competent personnel is critical to the safe execution of tests that deliver reliable test results. It is important that the Technical Rules, when referring to tests, require that they be conducted by appropriately qualified persons.

As appropriate, some clauses in the Technical Rules specify that a suitability qualified person must undertake tests and sign off on activities such as the commissioning of generators. Qualified persons are referred to in the Technical Rules as chartered professional engineers with National Engineering Register (NER) standing qualified in a relevant discipline or personnel experience in the area required. For example, clause 4.2.5(g) of the Technical Rules states:

> *"All commissioning tests under this clause 4.2.5 must be carried out under the supervision of personnel experienced in the commissioning of power system primary equipment and secondary equipment".*

7.2.1 Current issue

Western Power has identified a series of clauses where the use of an appropriately qualified person is insufficiently specified. Unqualified testing personnel can lead to inaccurate testing results or unsafe testing procedures; hence it is important to ensure personnel with appropriate qualifications and experience perform testing.

Clauses where the use of a suitability qualified professional is required are summarised in Table 7-1.

Table 7-1: Clause to be updated to ensure a suitability qualified person undertakes activities, tests, and sign-offs

Clause	Description of drafting and issue
Cause 4.1.2	Clause 4.1.2 of the Technical Rules details the right of Users or the Network Service Provider to require equipment owners of suspected non-compliant equipment to conduct testing to demonstrate compliance. Clause 4.1.2(e) of the Technical Rules states that the testing requested under clause 4.1.2 "may be conducted only by persons with the relevant skills and experience." This sub-clause is vague in its qualification requirements of the tester. While this may be necessary due to the range and level of difficulty of testing that can be conducted under this clause, clause 4.1.2 of the Technical Rules will benefit from more specific and explicit qualification requirements.
Clause 4.1.3	Clause 4.1.3 of the Technical Rules details the need for Generators to demonstrate their equipment's compliance with the connection requirements. Clause 4.1.3(a)(3) of the Technical Rules states that these compliance tests are to take place only after a suitably qualified chartered engineer has tested and certified the installed equipment. While clause 4.1.3(a)(3) of the Technical Rules requires the initial compliance testing be performed only after the generator has been tested and certified by an appropriately qualified engineer, there is no requirement for a qualified person to undertake the compliance tests. Clause 4.1.3 of the Technical Rules would benefit from an additional sub clause requiring that the tests to demonstrate connection requirement compliance are supervised or undertaken by a chartered engineer experienced in the operation of the specific equipment.

Clause	Description of drafting and issue
Clause 4.1.5	Clause 4.1.5 of the Technical Rules details the responsibilities of a User to perform a test on their equipment that requires the facility to be operated in a manner that is different to that described in their connection agreement. Operating equipment in a manner that differs from that contemplated in the connection agreement creates a significant risk to Power System Security as the connection agreement enforces a user to operate in a manner to maximise power system security. Currently, there is no sub-clause that requires that these tests are overseen by an appropriately qualified person. As these tests are undertaken with significant inherent risk to the Power System it is prudent to require that an additional sub-clause is added requiring that these tests are undertaken by a chartered engineer with experience in the relevant field.

7.2.2 Solution options & preferred solution

Western Power considered the following options that would address this issue:

a) Adopt similar requirements as those that appear in clause 4.2.5(g) of the Technical Rules in relevant clauses identified as having an issue (refer to Table 7-1) to guide the qualifications of those who should undertake tests to determine compliance.

b) No change.

Western Power proposes drafting consistent with option a). Changes consistent with option a) will ensure the appropriately qualified person undertakes critical activities and tests. The revisions will help maintain system security by requiring that appropriately experienced personnel oversee commissioning and compliance tests. Accordingly, the proposed revisions to the Technical Rules include amendment of clause 4.1.2(e), addition of a new clauses 4.1.3(a)(5) and 4.1.5(i).

In addition to the proposed solution, Western Power considered options for the clauses listed above to adopt a narrowed specification of the experience required in each case. However, increased specificity is not recommended as adopting narrowed definitions can be counterproductive by inadvertently excluding some personnel who have appropriate experience and thereby placing unnecessary restrictions on Users.

7.3 Notification of power system tests

Power system tests are required to confirm that the transmission, distribution or power systems are performing to requirements.

Clause 4.1.7 of the Technical Rules sets out the criteria for tests required by the User, the Network Service Provider or System Management, including the notice periods given by the Network Service Provider before tests can be conducted. Power system tests are performed in accordance with this clause to verify the power transfer capability of the transmission or distribution system and to investigate power system performance. The tests are critical to the ongoing reliability of the distribution and transmission systems as they allow Users and the Network Service Provider to verify the capability of the power system by calibrating the measured and simulated performance.

7.3.1 Current issue

Clause 4.1.7(d) of the Technical Rules requires the Network Service Provider to provide Users who could reasonably be expected to be affected by a proposed test with at least 15 business days' notice of a proposed power system test. It has been identified that 15 business days' notice is too short for potentially impacted Users to enter a state of readiness or adequately identify the risk imposed on the operation of their facilities. If the Network Service Provider opts to provide the minimum notice period, Users may be ill-prepared for the power system test and the risk of operational incidents with consequential risks to power system security increases.

A related issue is the lack of required consultation between the Network Service Provider and potentially impacted Users. For example, clause 4.1.7(c) requires the Network Service Provider to conduct tests requested by System Management or a User unless it considers that the grounds for testing are unreasonable. Throughout 4.1.7, the requirement (or right) for the Network Service Provider to conduct power system tests to conduct test regardless of input from affected Users creates potential risks. Where appropriate input from Users is not sought or considered, this may result in Users not fully understanding the implications or effect the proposed test, resulting in Users being ill-prepared for the required changes in operation during the test.

In other jurisdictions, the notice period that applies for similar tests is longer. For example, the Great Britain Distribution Code (DOC 12.4.1.1) requires a distribution network operator or a User to give six months of notice of a proposed system test when that test may have an effect on the others' systems.[57] The proposal to undertake such a test must be given in writing, and there is a process for recipients of the information to notify the test proposer if the information provided in the proposal notice is insufficient.

7.3.2 Solution options & preferred solution

Western Power considered the following options that would address this issue:

a) Add a new subclause in clause 4.1.7 of the Technical Rules specifying that if the Network Service Provider is satisfied that a system test is necessary, it must develop a proposed test procedure. The test procedure will describe how the tests will be undertaken and identify any potential impacts on Users during the tests. The test procedure will be finalised through consultation with affected Network Users. The Network Service Provider will be required to publish the draft test plan at least two months before the start of any test.

b) No change.

Option a) is preferred as the development of a test procedure and appropriate engagement with affected Users will help ensure:

- involved parties have a shared understanding of the process,
- that the User or Users understand the implications to their operations during the tests, and
- sufficient time is provided to allow affected Users to effectively identify and action any changes needed to manage their operations during a proposed power system test.

Provisions in the WEM Rules currently specify conditions under which a User should submit a commissioning test plan for approval by AEMO[58]. Further guidance is provided in the Commissioning Tests Power System Operating Procedure[59] that specifies the level of detail required in those plans, including notice periods. In some instances, system tests may need to be coordinated with the commissioning of User facilities. In those instances it is expected that the system test procedure would be appropriated aligned with the commissioning test plan developed in accordance with the WEM Rules.

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57 The Distribution Code of Licensed Distribution Network Operators of Great Britain, Issue 34, 7 September 2018, DOC12.4.1. Available at: http://www.dcode.org.uk/assets/uploads/D_Code_v34_clean_-_Published_070918.pdf

58 Refer to section 3.21A of the WEM Rules.

59 AEMO, WEM Rules – Power System Operation Procedure: Commissioning Tests, 1 June 2019. Available at: https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/wa_wem_consultation_documents/2018/aepc_2018_06/final/psop--commissioning-tests-clean.pdf?la=en&hash=2CD741BEBA49A57B197A979C704E78C8

Failing to change the Technical Rules risks confusion around the process for system tests and providing inadequate notice to Users potentially disrupts their activities. Therefore, maintaining the existing drafting is not recommended.

7.4 Aligning GPS compliance with the WEM Rules

Proposed changes to clause 3.3 of the Technical Rules (outlined in section 6 of this submission) introduce similar generator performance standards (**GPS**) arrangements to those in the WEM Rules for large generators (>5 MVA), both transmission and distribution connected. These larger generators play a critical role in power system security.

Revisions to the WEM Rules introduce a range of new obligations, processes and roles with respect to testing and ongoing monitoring of GPS compliance for transmission connected market generators.[60] Those provisions, in many instances, differ from the existing provisions in Chapter 4 of the Technical Rules. The provisions in Chapter 4 of the Technical Rules will apply to similar-sized generators that do not participate in the WEM and may be connected to the transmission or distribution networks.

7.4.1 Current issue

While complete alignment is not possible between the Technical Rules and the WEM Rules[61], there are advantages in aligning the compliance arrangements for large generators across the two instruments.

These large generators can have a significant effect on the operation of the power system so they should be treated the same regardless of the regulatory instrument that applies to their facilities. Further, misalignment between the WEM Rules and Technical Rules where larger generators are concerned creates complexity in registration and potential confusion for operators and facility owners.

A gap in the alignment of the compliance regimes would also be inconsistent with changes in Chapter 3 of the Technical Rules that recommend the adoption of GPS and a negotiation process similar to that which applies in the WEM Rules to larger generators covered by the Technical Rules.

7.4.2 Solution options & preferred solution

Western Power considered the following options:

a) Revise relevant provisions in Chapter 4 of the Technical Rules covering compliance monitoring and reporting, testing and commissioning of large generating systems to align reasonably closely with the WEM Rules. The Network Service Provider will be assigned roles allocated to AEMO in the WEM Rules regarding approval of compliance plans and receipt of non-compliance notifications, etc. The Technical Rules will leverage the procedures in the WEM Rules wherever possible (e.g., compliance plan template).

b) Adopt similar revisions to option a) for all generating system regardless of size.

c) No change.

Option a) is recommended as it makes the Technical Rules a more valuable instrument providing additional clarity for connecting parties, including regarding whether the WEM Rules of Technical Rules compliance regime applies to large generators. It also maintains a broadly consistent approach between the WEM Rules and the Technical Rules for larger generators that assist in delivering system security.

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60 Market generators in both the proposed Technical Rule changes and in the WEM Rules are those that are registered as a Market Generator in accordance with the WEM Rules.

61 The Technical Rules cannot place obligations on AEMO as the System Operator, for example.

Large generators captured by the processes in Chapter 4 of the Technical Rules have a similar potential to create adverse system security impacts if they fail to perform in accordance with their technical requirements as market generators who fail to meet the GPS requirements defined through the WEM Rules process. It is therefore appropriate that similar compliance obligations exist for both classes of generation.

Option b) is not recommended as they would leave large generators who negotiate their GPS via the updated Technical Rules with a reduced requirement to undertake ongoing compliance assessment. This is likely to provide inferior system security outcomes compared to option a).

The proposed revisions to the Technical Rules implement option (a) by including:

- Amendment to clause 4.1.3 clarifying when the compliance process in the WEM applies and when that in the Technical Rules applies
- Addition of clause 4.1.3(a)(3) requiring compliance testing following a relevant generator modification
- Revision of clauses 4.1.3(b) and (c).

As discussed further in section 7.7, option b) was not preferred as it would create an undue compliance burden for Users with small generating systems.

7.5 Option to renegotiate GPS where non-compliance is detected

GPS are required to ensure power system security. It is critical for a generator to comply with the agreed GPS because if a sufficient number of generators become non-compliant, the security of the power system can become threatened. An insecure power system is susceptible to faults resulting in poor reliability and potentially major loss of supply events.

7.5.1 Current issue

Chapter 4 of the Technical Rules is drafted as a once-through process, meaning that there is currently no avenue for a generator to revisit or re-negotiate their GPS obligations in response to non-compliance detected via tests conducted under chapter 4.

Proceeding with relevant modifications to generating equipment can alter the ability of generators to comply with their GPS. It is therefore appropriate that relevant generator modification trigger an appropriate review of the ability to meet GPS. This review should allow the generator and the Network Service Provider to renegotiate the GPS so that the Network Service Provider can ensure power system security while allowing the generator to adjust settings and equipment to optimise their operations.

7.5.2 Solution options & preferred solution

Western Power considered the following options to address the above issue:

a) For large generators, extend clauses covering the review of test results to allow for the potential to renegotiate GPS for larger generators. Where a renegotiation is required, the clauses in Chapter 4 should reference the relevant process in Chapter 3 of the Technical Rules.

b) Preclude renegotiation triggered by non-compliance, but allow renegotiation triggered by proceeding with a relevant modification to the generating system. This is best achieved by a modification to clauses in Chapter 3 of the Technical Rules to align with similar drafting in clause 3A of the WEM Rules. Clauses in Chapter 4 should provide for renegotiation between the interim and final approvals to operate (outlined in section 7.10 of this submission) if required following tests conducted under an interim approval to operate.

c) No change.

Western Power has identified option b) as the preferred option. Amendments to allow renegotiation of GPS to reflect modifications provides appropriate flexibility for both Users and the NPS to adapt and proactively manage settings over time. However, allowing generators to renegotiate GPS following a non-compliance, as envisioned in option a), weakens the obligation on these Users to ensure their ongoing compliance.

A proactive approach to renegotiation of GPS settings ahead of planned changes (and excluding non-compliance) will ensure the Network Service Provider and AEMO can continue to rely on records of the technical requirements when managing the power system.

7.6 Rectification of non-compliance

Users can become non-compliant with their agreed GPS and specified technical requirements due to operational changes or the replacement of equipment. Non-compliant Users may threaten power system security, for example, by lowering the power system's fault ride-through capability. Hence, it is necessary for the Network Service Provider to possess some mechanism to enforce compliance by Users with the agreed standards and technical requirements or, if necessary, take appropriate action to ensure power system security is maintained.

Clauses 4.1.2(j) and 4.1.3 of the Technical Rules detail procedures for rectifying non-compliance issues with User equipment detected in testing. While the clauses place responsibility on the User to rectify non-compliance, they do not outline sanctions the Network Service Provider may apply as an enforcement mechanism, nor do they require ongoing operation monitoring to confirm equipment compliance has been achieved following any remediation activities. In the absence of other provisions, the only remedy available to the Network Service Provider is disconnection.

7.6.1 Current issue

The current drafting of clauses 4.1.2 and 4.1.3 of the Technical Rules do not provide for appropriate escalation measures prior to disconnection of a User if remediation to address non-compliances are not undertaken in a timely and effective manner.

The lack of intermediate remediation measures does not align with requirements in Great Britain or under the WEM Rules. In Great Britain, continued failure by a user to rectify a non-compliance situation (e.g., operating outside technical parameters) results in the user being disconnected either as a breach of their Connection Agreement or a breach of the Distribution Code (DC DCode DOC5.4.9). However, the Great Britain Distribution Code also contains a section (DOC5.6.6 Dispute Resolution) detailing the process to be followed by a generator following failure to meet technical parameters identified from a test. This includes a proposed rectification plan and expected compliance date. Chapter 3A of the WEM Rules specifies arrangements for developing rectification plans and implementing rectification activities when required, including the requirement to notify the ERA and Network Operator of any non-compliance.

In addition to the issues above, Western Power also considers clauses 4.1.2(j) and 4.1.3 of the Technical Rules do not provide enough detail around the process of reattainment of compliance.

7.6.2 Solution options & preferred solution

Western Power has identified the following options to address the above issues:

a) Extend clause 4.1.3 of the Technical Rules to adopt a process similar to that in the WEM Rules if testing reveals a non-compliance.

b) In addition to option a) include clauses that describe the actions that the Network Service Provider may take in response to failed attempts to rectify any non-compliance. These additional clauses will allow actions ranging from issuing a warning letter to disconnection of non-compliant equipment. An additional clause will also provide for the development of a plan of action with clear dates associated with actions.

c) No change.

Western Power considers option b) to be the preferred solution, as it provides a more complete solution. Proposed changes will ensure that non-compliances are consistently treated regardless of how they are detected. Updated clauses provide:

- better guidance regarding what is expected from Users to rectify any non-compliance.
- better definition of the rectification process than current arrangements, which should improve consistency of treatment of non-compliance and improve system security.
- the Network Service Provider (and AEMO) additional enforcement mechanisms allowing appropriate actions to be taken to ensure a secure power system.

7.7 Compliance provisions for small generators

For smaller generators (≤ 5 MVA), obligations that ensure compliance with technical requirements are needed that do not impose a cost on these smaller connections that is disproportionate to the risk posed by an individual non-compliance.

7.7.1 Current issue

The current framework in chapter 4 of the Technical Rules generally provides for compliance assessment performed during initial commissioning with provisions allowing the Network Service Provider to request additional testing when considered necessary.

Given the requirements for inspection, testing and commissioning that apply to large generators are being updated to align with WEM Rules changes (refer to section 7.4 of this submission), Western Power has considered whether the existing Chapter 4 requirements should be retained or updated for small generating systems.

7.7.2 Solution options & preferred solution

Western Power considered the following options to address the above issue:

a) Maintain the existing approach in Chapter 4 of the Technical Rules for all Users, other than those controlling large generating systems, that does not require ongoing monitoring and testing to confirm compliance with technical requirements (differentiated from protection requirements covered in Attachment 12). The User is required to confirm compliance during initial commissioning

b) Extend the regime developed for larger generators to small generators and loads that require Users to undertake testing and monitoring to provide an ongoing demonstration of compliance with their technical regimes, executing test plans agreed with the Network Service Provider, reporting any non-compliance to the Network Service Provider and agreeing with the Network Service Provider rectification actions.

Option a) is the preferred option as it provides the right balance between compliance costs and system security for these smaller generators, and it allows for testing following specified trigger events.

Option b) is not necessary as the existing provisions provide adequate opportunities for the Network Service Provider to require testing to investigate suspected non-compliance.

7.8 Obligation for Users to update computer models and associated parameters

Computer models are used in software simulation packages (such as Power Factory) to model the power system. The Network Service Provider and AEMO rely on tests performed by Users to verify and update their computer models with respect to connected assets so that the models accurately reflect actual performance. The need to revise computer models may also be identified through power system test completed in accordance with clause 4.1.7 of the Technical Rules.

As the Network Service Provider and AEMO rely on power system simulations that use models supplied by Users to make decisions about the operation and planning of the power system, it is critical for those models to reflect, as closely as reasonably possible, the actual performance of the assets. If modelling information originally provided during the connection process proves to be inconsistent with actual measured performance, it is critical that the modelling deficiencies are corrected. Failure to do so could lead to incorrect assumptions in the way the Network Service Provider and AEMO operate the power system.

7.8.1 Current issue

Obligations in the Technical Rules require Users to provide information to the Network Service Provider and AEMO at the commissioning stage[62]. However, the obligations for Users to provide updated computer model information where subsequent testing has revealed an inconsistency between theoretical and actual performance is not clear.

While model validation is noted as a purpose for tests undertaken under clauses 4.1.3, 4.1.6 and 4.1.7 of the Technical Rules, Western Power has identified issues in the drafting of the following clauses in Chapter 4 of the Technical Rules related to Users providing updated computer models and associated parameters:

- Clause 4.1.3 (a)(1) Test to demonstrate compliance with connection requirements for generators
- Clause 4.1.6 Testing of generating units requiring changes to agreed operation
- Clause 4.1.7 (j) Power system tests

7.8.2 Solution options & preferred solution

Western Power considered the following options to address the issue outlined above:

a) Update the Technical Rules to require Users to update models and associated information to the Network Service Provider beyond initial commissioning requirements, consistent with the changes to the WEM Rules. This requires changes to clauses in Chapter 4 of the Technical Rules to require Users to provide sufficient data and information following testing for the Network Service Provider and AEMO to update their computer models to reflect the results of the tests.

b) No change.

Western Power proposes adopting option a). Adopting this option will ensure obligations on Users to provide modelling information to the Network Service Provider and AEMO is clearly set out. This ensures

[62] For example, clause 4.1.3(a) of the Technical Rules requires Generators to provide evidence, including in the form of modelling information and data sufficient to produce accurate computer models to the Network Service Provider and System Management to commencing commercial operations, as part of its connection requirements.

that tests the Network Service Provider or AEMO rely on to verify the performance of the connected assets provide enough data and information to update the Network Service Provider's and AEMO's computer model to reflect the results of the tests.

Adoption of the changed drafting also aligns with:

- changes to the WEM Rules, as reflected in clause 3A.2.2, which requires that transmission connected generating systems participating in the WEM provide as generating system model that complies with the modelling procedure developed by the Network Operators in accordance with clause 3A.4.2 of the WEM Rules.
- revisions proposed for Chapter 3 of the Technical Rules that reinforce that the User is responsible for ensuring the computer model provided reasonably reflect the plant performance as specified in the model guidelines produced by the Network Service Provider.

The changes to Chapter 4 and the revised obligations in Chapter 3 will, in practice, act as a general requirement for Users to ensure their computer models and associated parameters are accurate with the operation of their generator units.

7.9 Right to request information

The Network Service Provider requires adequate knowledge of the equipment within a Users' facility to understand potential implication for the operation of the power system. The Technical Rules currently provide a right to inspect facilities as a means for confirming details of connected equipment.

In many cases the need for an inspection could be avoided by the User providing information on the connected equipment.

Accurate information regarding a User's facility that is made available on request is necessary for the Network Service Provider to assess the ongoing impact of the User's facility on the performance and security of the transmission and distribution system.

There are three clauses in Chapter 3 of revision 3 of the Technical Rules that cover the provision of information from Users, in this case, Generators and Consumers, to the Network Service Provider:

- Clause 3.3.2 of the Technical Rules requires the Generator to provide all data reasonably required by the Network Service Provider to assess the impact of connection of a generator to the transmission or distribution system.
- Clause 3.4.5 of the Technical Rules requires a Consumer (that is, a user operating a load facility) before connection to the transmission or distribution system to potentially provide the information detailed in Clause 3.4.5(b) (1) to (13) of the Technical Rules. This information is used by the Network Service Provider to design and install the connection assets and determine the impact of connecting the load to the transmission and distribution system.
- Clause 3.6.3 of the Technical Rules requires a small Generator (or small power station) to provide information as detailed in clauses 3.6.3(b) and (c) on the design, construction, operation and configuration of that Generator. This information is needed for the Network Service Provider to determine if the connection of that Generator will have a negative effect on the distribution system.

These requirements have been retained in the proposed revisions to chapter 3 of the Technical Rules. They form part of the User's condition of connection. Hence, the provisions of information that are required by Clauses 3.3.2, 3.4.5 and 3.6.3 of the Technical Rules will be difficult to apply to existing Generators and Loads (who have already gone through the connection process).

7.9.1 Current issue

Currently, within the Technical Rules, there is no specific clause that allows the Network Service Provider to request information from Users.

Operational settings can change over time, and equipment is replaced from time to time. The inability of the Network Service Provider to request up-to-date information may result in the Network Service Provider's register of information on the facilities connected to the distribution and transmission systems to drift from actual specifications. Failure to address this information gap can lead to system security issues if the Network Service Provider and AEMO are unaware of the performance of User equipment (even where the levels are within compliant requirements).

7.9.2 Solution options & preferred solution

Western Power considered the following options to address the above issue:

a) Redraft clause 4.1 of the Technical Rules to include a new clause that establishes the right for the Network Service Provider to request information from Users, which allows the Network Service Provider the ability to gather information from Users (both existing and new) and share this information with AEMO where appropriate.;

b) No change – rely on the existing provisions in chapter 3, even for existing generators.

Option a) is the preferred solution as it addresses a gap in the current Technical Rules that fails to provide an explicit right to for the Network Service Provider to request information. This right will be important to allow the Network Service Provider to confirm the technical capability of legacy User facilities. Additionally, an information provision will be a more efficient way of obtaining information as opposed to the inspection processes currently allowed by clause 4.1.1 of the Technical Rules.

The changes proposed in Chapter 3 of the Technical Rules (outlined in section 6 of this submission) mean it is neater to provide for the requirements in Chapter 4 in a single location. As such, option b) is also not desirable in the context of other changes.

7.10 Interim and final approval processes

Recent revisions to the WEM Rules implemented an enhanced process for generators participating in the WEM to gain approval to operate. The process provides a staged approval framework consisting of an interim approval to operate to allow testing, with that approval replaced by an approval to operate on successful completion of tests to demonstrate compliance with technical requirements. This process supports the maintenance of power system security by clarifying the process for large generating systems to demonstrate that they are meeting expected performance requirements.

7.10.1 Current issue

Chapter 4 of the Technical Rules does not provide for staged interim and final approvals to operate for large generators. This means that the commissioning process defined in the Technical Rules is not aligned with that defined in the WEM Rules for transmission connected generating systems that participate in the WEM. Specifically, the Technical Rules do not allow for a User to be granted an interim approval to operate to allow demonstration of performance. There is also not clearly defined process for allowing operation once a User has demonstrated that their facility meets the relevant technical requirements.

Adopting a similar interim and final approval processes to that applying under Chapter 3A of the WEM Rules, would help align the processes in the Technical Rules and the WEM Rules providing improved clarity for Users.

7.10.2 Solution options & preferred solution

Western Power has identified the following options to address the above issues:

a) Amend clause 4.2.2 of the Technical Rules to add clauses implementing interim approval to operate and final approval to operate arrangements similar to those in the WEM Rules.

b) No change.

Western Power prefers option a) as it allows the User temporary permission to operate so that tests can be undertaken to prove compliance with technical performance with the final approval to operate issued once compliance has been validated. This provides a pragmatic framework allowing the temporary operation of User facilities necessary to demonstrate compliance.

The requirement for final approval to operate following an interim approval stage should provide a more robust process helping to prevent Users from operating facilities if they had not demonstrated compliance within the timeframes agreed when the interim approval was granted. The option for an interim approval should enhance the ability to meet system security and provide improved clarity for Users regarding the process and approvals associated with commissioning.

Option a) also aligns with the approach adopted in the WEM Rules.

8. Transmission and distribution system operation and coordination

Chapter 5 of the Technical Rules defines requirements for the operation and co-ordination of the Network Service Provider's and Users' facilities. The requirements in chapter 5 are intended to complement rather than duplicate related provisions in the WEM Rules.

The structure of this chapter of the Technical Rules is illustrated in the following diagram.

5.1 - Application

5.2 – Introduction

5.3 – Power System Operation Co-ordination Responsibilities and Obligations

5.4 – Control of Transmission System Voltages

5.5 – Protection of Power System Equipment

5.6 – Power System Stability Co-ordination

5.7 – Power System Security Operation and Co-ordination

5.8 – Operations and Maintenance Planning

5.9 – Power System Operating Procedures

5.10 – Power System Operation Support

5.11 – Nomenclature Standards

The limitations, issues and proposed solution to address issues that have been identified through the Technical Rules review process are discussed in the sub-sections that follow.

8.1 Clarifying Network Operator roles and responsibilities

The existing structure of chapter 5 does not differentiate the specific roles and responsibilities for operating the transmission and distribution networks performed by Western Power. The current drafting assigns operational obligations to either Users, the Network Service Provider or System Management.

8.1.1 Current issue

As System Management is no longer part of Western Power it is appropriate to revise Chapter 5 of the Technical Rules to clarify the operational responsibilities that remain with Western Power. Providing improved clarity around operational responsibilities will also support ongoing reforms that are considering whether a Distribution System Operator role should be defined and what activities should be allocated to the Distribution System Operator.

8.1.2 Solution options & preferred solution

Western Power considered the following options to address this issue:

a) No change to existing structure with all operational roles performed by Western Power expressed as Network Service Provider obligations.

b) Clarify Western Power's operational roles and responsibilities by separately specifying Distribution Network Operator and Transmission Network Operator roles and restructuring Chapter 5 to group obligations

c) Clarify Western Power's operational roles and responsibilities by separately specifying Distribution Network Operator and Transmission Network Operator roles, while maintaining existing structure for Chapter 5

d) Clarify Western power's operational roles and responsibilities by defining Distribution Network Operator and Transmission Network Operator roles and further differentiating operational obligations applicable for market participating entities and those who do not participate in the WEM.

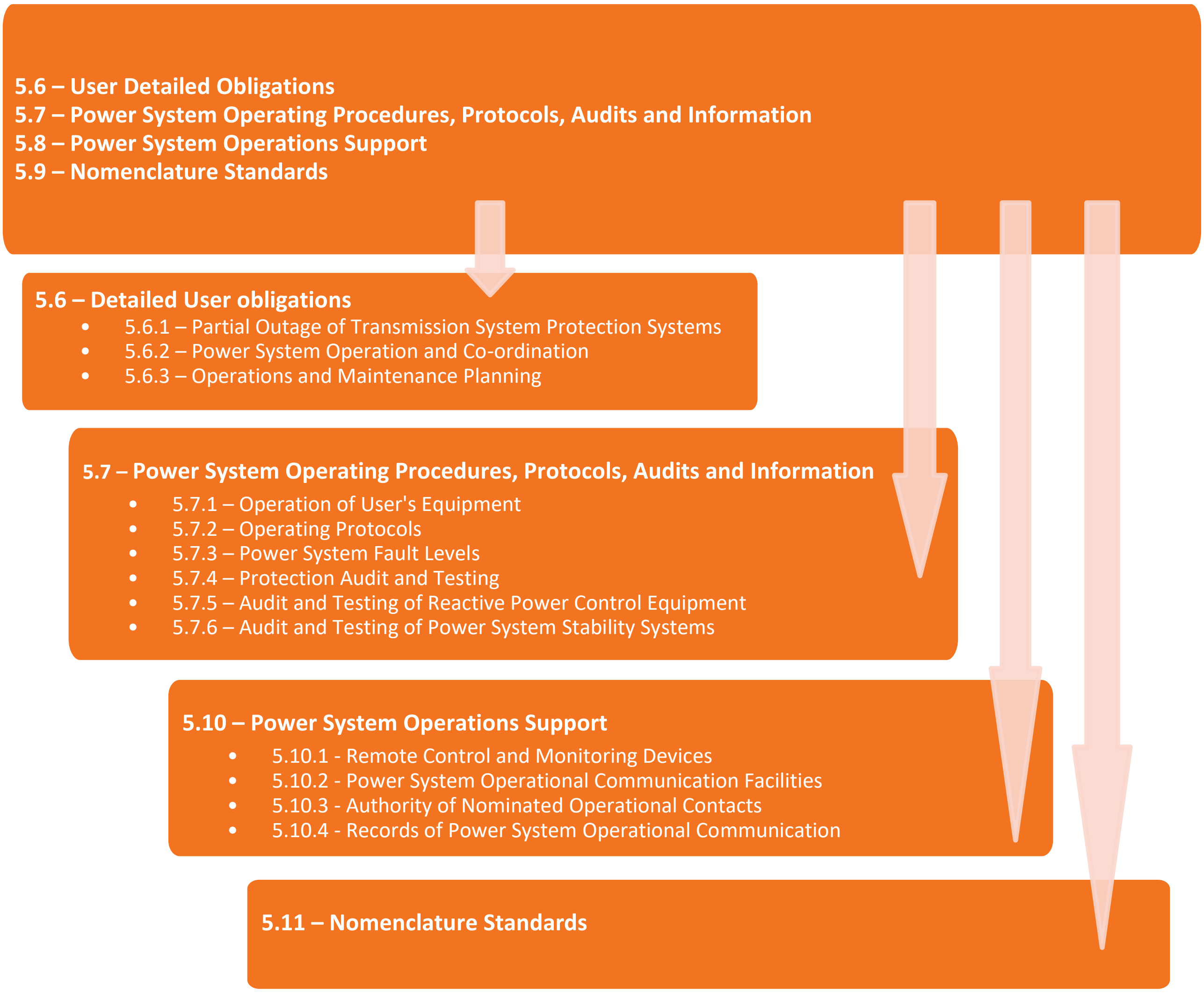
Western Power proposes changes consistent with option b). The proposed approach substantially restructures chapter 5. Compared to other options, the proposed changes provide much greater clarity regarding the operational roles and responsibilities allocated to Western Power as the operator of the transmission and distribution networks. The greater clarity will benefit stakeholder and assist with making any subsequent revisions necessary to accommodate distribution system operator functions.

The proposed changes result in the structure shown in Figure 8-1 and Figure 8-2. In addition to the structural changes the introduction provided in clause 5.3.1 was expanded to explain that in Chapter 5 of the Technical Rules the Network Service Providers operational obligations and responsibilities have been classified as Transmission Network Operator or Distribution Network Operator obligations and responsibilities.

In the remainder of this chapter unless otherwise stated any clause number in chapter 5 of the Technical Rules refers to the restructured clauses illustrated in Figure 8-1 and Figure 8-2.

Figure 8-1: Overview of revised structure for Chapter 5

Figure 8-2: Overview of revised structure for Chapter 5



8.2 Application

Clause 5.1 of the Technical Rules provides high-level guidance regarding the application of the specified operational requirements. The current drafting states:

> *This section 5 applies to the operation and coordination of the Network Service Provider's and Users' facilities to the extent not covered under the Market Rules. For Market Generators (as defined under the Market Rules, and generally being Generators the rated capacity of whose generating system equals or exceeds 10 MW) the rules that apply for power system operation and coordination are those found within the Market Rules.*

8.2.1 Current issue

The application guidance provided in clause 5.1 of the Technical Rules requires amendment to address the following issues:

- The clause currently recognises that generators participating in the WEM must comply with the relevant operational arrangements specified in the WEM Rules. This could result in confusion as the requirement to comply with the WEM Rules applies to all WEM participants, not just generators with a rated capacity equal to or exceeding 10 MW.

- The clause is currently silent on whether the Technical Rules specify the requirements for operational coordination between Western Power and AEMO. This omission has the potential to create confusion.

8.2.2 Solution options & preferred solution

Western Power considered the following options to address the above issues:

a) Delete references to the need for any WEM Participants to comply with the operational arrangements defined in the WEM Rules and rely on Users knowing those requirements are specified in the WEM Rules.

b) Refining clause 5.1 to note that all WEM participants must comply with the relevant operational requirements in the WEM Rules and to clarify the requirements for the operation and coordination between the Network Service Provider and AEMO are described in the WEM Rules and not included in chapter 5 of the Technical Rules.

Option b) is recommended as it provides guidance that will assist stakeholders in understanding the relationship between the operational requirements specified in the WEM Rules and the Technical Rules.

8.3 Alignment with revisions to network planning criteria and network service provider obligations

As discussed in sections 3 and 4 of this submission, various revisions are proposed to the Network Service Provider obligations and the network planning criteria specified in chapter 2 of the Technical Rules. Those revisions necessitate an adjustment to related provisions in chapter 5 of the Technical Rules.

8.3.1 Current issue

To align with the revisions to the planning criteria, additional clauses were added to Chapter 5 of the Technical Rules to define operational criteria that Western Power seeks to meet when planning and operating the power system with the criteria:

- Recognising the need to operate the system consistent with the power system performance standard defined in Chapter 2 of the Technical Rules,
- Providing alignment with the planning criteria specified in chapter 2 of the Technical Rules, and
- Aligning with the power system security provision defined in the WEM Rules.

The revisions to Network Service Provider obligations in chapter 2 clarify obligations on the Network Service Provider to provide information to Users and network limit advice to AEMO. For consistency various clauses in Chapter 5 that addressed similar requirements were deleted where the requirements were adequately defined in Chapter 2 of the Technical Rules

8.3.2 Solution options & preferred solution

Revisions were made to the following clauses in chapter 5 of the Technical Rules to maintain alignment with the revisions introduced in Chapter 2 of the proposed Technical Rules:

- Clause 5.2.1(a)(3) was added to clarify that Chapter 5 specifies operational criteria with the criteria applicable to the transmission network specified in clause 5.4.1 of the proposed Technical Rules and that applies to the distribution network defined in clause 5.5.1 of the proposed Technical Rules. The operational criteria specified in sections 5.4.1 and 5.5.1 of the proposed Technical Rules have been defined to reflect the criteria assumed when planning the network as specified in the transmission and distribution planning criteria defined in section 2.5 and 2.6 of the proposed Technical Rules. The proposed transmission planning criteria includes specific requirements regarding network loading, fault levels, voltage conditions and stability which must be achieved in planning timeframes. For consistency the operational criteria for the transmission system are specified in a similar manner in clause 5.4.1 of the proposed Technical Rules.

- Information provision requirements that appear as clause 5.3.2(a) and (b) in the current Technical Rules were deleted.
- Stability coordination requirements that appear as clause 5.6 in the current Technical Rules were deleted.
- Requirements specified in clause 5.4.1 in the current Technical Rules that require the Network Service Provider to assess and determine the limits of the operation of the transmission and distribution system were deleted as the limit determination obligations are now specified in clause 2.3.6 of the Technical Rules.
- As discussed in section 8.5, clause 5.4.5 of the proposed Technical Rules now includes guidance on the need to consider the ability to comply with the transmission planning criteria specified in chapter 2 of the Technical Rules when planning network outages.

8.4 Addressing technologies bias

It is important that the Technical Rules avoid drafting that is particularly biased towards particular technologies. Adopting this approach helps ensure that all options are considered allowing the most efficient investments to proceed.

8.4.1 Current issue

Clause 5.4.1(f) in the current Technical Rules lists technologies which may be utilised by reactive power facilities. The list does not include other technologies capable of providing reactive power, including inverter connected generating systems and electricity storage systems. The limited technology list may be construed as limiting the technology which can be deployed to provide reactive power facilities, which if adhered to could prevent the most efficient solution from being deployed.

8.4.2 Solution options & preferred solution

Western Power considered the following options to address this issue:

a) Extend the list of technologies listed in this clause to include inverter connected generating systems and electricity storage facilities,

b) Extend the list of technologies listed to include any technology capable of absorbing or injecting reactive power at the point of connection to the power system, or

c) Delete the clause and revise adjacent clauses to avoid the need to include a list of technologies.

Option c) is recommended as it removes an unnecessary provision and thereby avoids any restriction on technologies that may be deployed to provide reactive power.

This change has been implemented through the revisions to clauses 5.4.2 and 5.5.2 in the technical Rules. These clauses specify voltage control obligations that apply to the Transmission Network Operator and the Distribution Network Operator, respectively.

8.5 Clarifying arrangements for planning network outages

The appropriate coordination of planned outages of the elements of the transmission and distribution network and User facilities is an important aspect of operational coordination addressed by chapter 5 of the Technical Rules.

8.5.1 Current issue

Clause 5.8 in the current Technical Rules specifies obligations on Users regarding the notification and management of outages of their facilities. This clause is not intended to apply to Users who are registered as Market Participants (under the WEM Rules). For those Users, the outage planning requirements are specified in the WEM Rules and the relevant Market Procedure.

While this clause clarifies the obligations on Users, it offers no guidance regarding the process that Western Power should follow in assessing when to schedule a network outage. The lack of information regarding network outage scheduling may create confusion for stakeholders.

The Facility Outages Procedure published by AEMO in the requirement in the WEM Rules identifies network elements that fall within the oversight of the outage management process described in the WEM Rules.[63] For those network elements, the processes in the Facility Outages Procedure apply. However, it is unclear what processes apply for outages of other network elements.

With the revisions to the transmission planning criteria, it is beneficial for the maintenance and outage scheduling provisions in Chapter 5 of the Technical Rules to provide guidance on the need to consider the ability to comply with the transmission planning criteria when planning network outages.

8.5.2 Solution options & preferred solution

Western Power considered the following options to address this issue:

a) Introduce new a clause 5.4.5 that provides a detailed description of the processes the Transmission Network Operator will following in planning network outages.

b) Introduce a new clause 5.4.5 that specifies:

   i) An obligation for the Network Service Provider to develop an outage assessment guideline,

   ii) A requirement for the Transmission Network Operator to follow those guidelines when planning outages,

   iii) High-level principles that should be reflected in an outage assessment guideline including the need to consider the transmission planning criteria when assessing outages, and

   iv) As required by the WEM Rules, provide transmission equipment outage requests to AEMO.

c) No change - Retain the existing drafting.

Option b) is recommended as it provides improved transparency regarding the process used to plan transmission outages. Providing the specific details in the guideline simplifies the drafting of the Technical Rules and allows a more efficient process for amending the guidelines as necessary to refine the outage planning process while maintaining consistency with the principles defined in the Technical Rules.

63 Facility Outages Procedure published by AEMO on 1 February 2020. Available at https://aemo.com.au/energy-systems/electricity/wholesale-electricity-market-wem/procedures-policies-and-guides/procedures

The proposed changes focus on improving clarity regarding the planning of transmission system outages as those outages have the potential to impact a much greater number of Users than distribution network outages.

8.6 Consistency with revised User requirements

As discussed in section 6 of this submission, various revisions have been proposed to the User technical requirements specified in chapter 3 of the Technical Rules. Those revisions necessitate adjustments to related provisions in chapter 5 of the Technical Rules.

8.6.1 Current issue

A number of clauses in chapter 5 of the Technical Rules recognise that to provide a secure power system, Western Power should be able to require Users to operate their facilities in a manner that will deliver the technical performance specified in Chapter 3 of the Technical Rules.

Issue 1: Western Power identified potential ambiguity with the wording of those clauses, with the ambiguity relating to:

- the extent to which Western Power can request generators to alter their active control modes, setpoints and the dispatch of active and reactive power, and
- whether specific additional contractual arrangements are necessary to ensure Users comply with such requests made by Western Power.

Issue 2: The User technical requirements in Chapter 3 require specified Users to provide remote monitoring control and communication equipment. The standards that a User needs to adhere to when providing this equipment are not adequately defined in the current version of the Technical Rules, which creates confusion for Users. Specific examples of this issue include clause 3.3.4.1(b) and clause 5.10.1 in the current Technical Rules. These clauses state only remote monitoring equipment must conform to an acceptable standard as agreed by the Network Service Provider, but no details of the specific standard are provided. User facilities that participate in the WEM must also have appropriate remote monitoring, control and communications equipment to satisfy AEMO's requirements as specified in relevant WEM procedures (made under the WEM Rules).

The clauses giving rise to the above concerns required re-arrangement to accurately specify Transmission Network Operator and Distribution Network Operator roles and responsibilities.

8.6.2 Solution options & preferred solution

The solution options and preferred solutions to the two issues above were addressed separately.

Issue 1: Western Power considered the following options to address the issue concerning the ability to request Users to operate their facilities to deliver the Technical Requirements established through the processes defined in Chapter 3 of the Technical Rules:

a) Introduce revisions to appropriate clauses that:

   i) Clarify that the Transmission Network Operator or Distribution Network Operator is required to operate those parts of the transmission or distribution system that are not under the control of AEMO so as to ensure that the power system performance standards as specified in clause 2.2 or clause 6.2 are met, and

   ii) Recognise that to achieve the above may require a User to operate its equipment as necessary to maintain and restore secure and reliable operation of the power system.

b) No change - Retain the existing drafting.

Option a) is recommended as it provides clarity regarding when Western Power may request a User to operate its equipment to maintain and restore secure and reliable operation of the power system. This solution recognises the role of all Users in contributing to achievement of the performance standards.

For clarity, the clause is not intended to allow Western Power to request Users to operate their equipment outside of the technical limits provided for in the Technical Rules or otherwise agreed with Users. As such this proposed revision does not impose any additional obligation on Users beyond delivering the technical performance consistent with meeting the relevant User technical requirements. It also clarifies that Western Power can access additional capability through contractual arrangements with Users.

This change has been implemented through the revisions to clauses 5.3.1(a) and 5.3.2(a) of the proposed Technical Rules.

Issue 2: Western Power considered the following options to address the issue concerning the ambiguity in the appropriate standards for remote monitoring, control and communication equipment:

a) Revise the existing clause in chapter 5 addressing remote control and monitoring devices to clarify that:

    i) Those devices must be installed, operated and maintained by a User in accordance with the standards and protocols determined by the Network Service Provider or AEMO, and

    ii) The Network Service Provider must publish a 'Generating system control and monitoring guideline', describing the signals that a User may need to monitor and make available to the Network Service Provider or AEMO. In developing the guideline, the Network Service Provider must consider the procedure developed in accordance with clause 2.35.4 of the WEM Rules.

b) No change - Retain the existing provisions which allow communication standards to be negotiated on a case-case basis.

Option a) is recommended as it provides greater clarity for Users regarding the standards that their facilities need to meet. This should facilitate a more effective and efficient connection process.

This change has been implemented through the revision to clause 5.8.1 in the proposed Technical Rules.

8.7 Clarifying the role of User operating protocols

User operating protocols are developed to record and clarify non-standard or complex operational arrangements specific to a User's facility. Chapter 5 of the Technical Rules should provide sufficient guidance regarding the process for developing and maintaining those protocols.

8.7.1 Current issue

Some User facilities are connected via more complex and non-standard connection arrangements. These situations can give rise to specific matters that need to be considered when coordinating the operation of the User facilities and the transmission and distribution system. Information could include:

- Specific arrangements to coordinate outages of User facilities and the transmission system or the distribution system.
- Specific actions required to coordinate the operation of the User Facilities with the connected network.
- Specific technical information required to co-ordinate operations including details of protection, metering locations and arrangements at the connection point.

A common approach for capture this additional information employed by Network Service Providers operating in the NEM is to develop an operating protocol as an attachment to a connection agreement. The benefit of this approach is that all operating protocols that a Network Service Provider needs to refer to are developed in a consistent manner. The consistency simplifies the use of the documents operationally and reduces the risk of misinterpreting.

Western Power currently captures this information in a variety of ways, and there is no specific requirement in the Technical Rules addressing the requirement to produce and maintain an operating protocol. The lack of any specific requirement in the Technical Rules has contributed to inconsistent approaches being adopted, leading to inefficient outcomes and risking confusion regarding the operational coordination between the Western Power and Users.

8.7.2 Solution options & preferred solution

Western Power considered the following options to address the issue concerning the ambiguity in the appropriate standards for remote monitoring, control and communication equipment:

a) Revise chapters 3 and 5 of the Technical Rules to include:

   i) Requirements for Users, when required by the Network Service Provider, to negotiate a User Operating Protocol consistent with template maintained by the Network Service Provider,

   ii) A requirement for the Network Service Provider to maintain a template for User Operating Protocols,

   iii) A requirement for Users to operate their facilities in accordance with any relevant User Operating Protocol, and

   iv) A requirement for Users to maintain the User Operating Protocol to ensure it continues to accurately record relevant operating arrangements for their facility.

b) No change.

Option a) is recommended as it provides greater clarity for Users and Western Power regarding when an operating protocol is required and encourages a consistent approach to producing operating protocols.

This change has been implemented through:

- The revision of clause 5.7.1(b) to require Users to operate their facilities in accordance with the User Operating Protocol.
- The addition of clause 5.7.2, which:
  - places an obligation on the User to negotiate a User Operating Protocol if required to do so by the network Service Provider;
  - requires User Operating Protocols to be consistent with the template developed by the Network Service Provider, and
  - places an obligation on the User to maintain the User Operating Protocol.
- Revision of clause 3.1(b) of the Technical Rules to recognise that the User Operating Protocol should capture any additional restrictions or requirements beyond those specified in the other clauses in chapter 3 that apply to the User facility. Relevant links are provided for in clauses 5.5.3(e) and 5.5.4(c) of the proposed Technical Rules to ensure the Transmission Network Operator and the Distribution Network Operator consider these arrangements when taking approved outages.
- Revision of clause 5.3.3(h) to state that unless otherwise agreed with the Network Service Provider a User must operate their facilities in accordance with any relevant User Operating Protocol.

8.8 Clarifying system security obligations for the DNO and TNO

In parallel with the review of the Technical Rules, electricity market reform processes have identified the need to amend the WEM Rules to provide greater clarity around the framework for managing power system security. It is important that the operational requirements specified in chapter 5 of the Technical Rules are consistent with the power system security framework specified in the amended WEM rules.

8.8.1 Current issue

The current drafting in chapter 5 of the Technical Rules is not consistent with the allocation of power system security obligations and responsibility to AEMO and Western Power in the WEM Rules. Approved Tranche 2 and 3 amendments to the WEM Rules clarify that AEMO takes required actions to maintain power system security, including issuing directions to Western Power.[64]

The approved amendments to the WEM Rules clarify that AEMO has primary responsibility for deciding those actions that need to be taken to maintain power system security while Western Power operates the network and supports AEMO to maintain power system security. Western Power roles include:

- operating the network consistent with AEMO directions,
- developing secure transfer limits for the power system,
- monitoring the power system and advising AEMO of any power system security issues, and
- coordinating the operation of the transmission network with AEMO in accordance with the operating protocol established between AEMO and Western Power.

8.8.2 Solution options & preferred solution

The following changes to clauses in chapter 5 of the Technical Rules are proposed to align the power system security obligations in the Technical Rules with those specified in the approved amendment to the WEM Rules:

- Adding a new clause 5.3.1(b) to clarify that the operational activities performed by the Transmission Network Operator must be coordinated with AEMO following the processes defined in the WEM Rules and further informed by the relevant operating protocol established in accordance with clause 3.1A of the WEM Rules.
- Amending clause 5.4.2(a) to specify that the Transmission Network Operator must monitor rather than determine the adequacy of the capacity to produce or absorb reactive power.
- The obligation specified in clause 5.4.1(d) in the current Technical Rules that requires the Network Service Provider to design and construct the transmission and distribution system to control voltages requires revision. The requirement to design and construct should be replaced by a requirement to monitor voltages on the transmission system and implement operational arrangements to maintain voltages with the operational voltage envelope specified by AEMO and the voltage limits specified in clause 2.2. This revision is achieved by changing clause 5.4.2(b). The change avoids any conflict with the transmission planning criteria and maintains consistency with the system security arrangements in the amendments to the WEM Rules.

  A similar amendment is required to clause 5.5.2(b) of the Technical Rules, which specifies voltage management requirements assigned to the Distribution Network Operator.

[64] Refer to clause 3.4.5 in the approved tranche 2 and 3 amendments to the WEM Rules. Available at Wholesale Electricity Market Rules (www.wa.gov.au)

8.9 Clarifying acceptable timeframes for protection outages

Faults on the transmission network need to be cleared quickly and reliably to limit the potential for adverse impacts on power system security and the reliability of supply to customers. Given the importance of transmission system protection, the current Technical Rules (clause 2.9.2 and 2.9.3) specify requirements for the level of redundancy and availability that should be achieved by transmission system protection systems:

- Clause 2.9.2(a)(1) requires that elements of the transmission system be protected by main system protection comprising two fully independent protection schemes.
- Clause 2.9.3 specifies availability targets for transmission system protection and allows outages of up to 48 hours duration without removing the protected equipment from service. For longer duration outages, the clause specifies that protected equipment will be removed from service unless:
  - otherwise instructed by AEMO, or
  - a risk assessment demonstrates that it is appropriate to leave the equipment in service.

Chapter 5 of the Technical Rules also considers the availability of transmission system protection, specifying actions that should be taken to manage the impact of protection system outages.

8.9.1 Current issue

The existing transmission protection partial outage provisions expressed in clause 5.5.4 in current Technical Rules defines the obligations on the Network Service Provider to assess the risk associated with operating elements of the transmission system while there is an outage of one of the redundant protection schemes.

Clause 5.5.4 recognises that allowing the transmission equipment to remain energised while there is a protection outage may be prudent in many scenarios as it allows necessary maintenance to proceed without impacting the reliability of supply to customers or creating constraints on the dispatch of generation. The clause also recognises that while a transmission element is being operated with only one protection scheme available, there is a heightened risk that a fault may not be cleared, creating a potential system security issue.

The existing drafting provides discretion for the Network Service Provider to decide whether the proposed length of a protection system outage is short enough to warrant keeping the protected transmission elements energised. However, the clause does not provide sufficient guidance to ensure the discretion is exercised appropriately and consistently.

8.9.2 Solution options & preferred solution

Western Power considered the following options to address the issue:

a) Adding a new clause in chapter 5 that requires that the Transmission Network Operator consider the availability requirements specified in clause 2.9.3 when assessing the impact of transmission equipment protection outages.

b) Expanding the existing provisions in chapter 5 to specify acceptable durations for protection outages.

c) Expanding the existing provisions in chapter 5 to specify acceptable durations for protection outages and clarify that AEMO's involvement in assessing whether it is acceptable to leave protected equipment energised if that equipment falls within AEMO's area of oversight as defined in the AEMO-WP Operating Protocol (refer to clause 3.1A of the WEM Rules).

d) No change.

Option a) is recommended as it provides improved guidance regarding how the Transmission Network Operator should assess protection outages. Referencing the requirements in chapter 2 from the clause in chapter 5 ensures that there is appropriate recognition of the protection system design requirements when making operational decisions. The approach also avoids duplicating design requirements in chapter 5, which avoids the risk of inconsistencies emerging over time if modifications to the provisions in on chapter were not reflected in relevant clauses in the other chapter.

Option b) is not preferred as it leads to duplication of requirements with the potential for inconsistencies to arise over time. Option c) is also not preferred as it unnecessarily duplicates requirements expressed in the WEM Rules.

Option a) is implemented through the addition of clause 5.4.3(d) in the proposed Technical Rules.

8.10 Adequate consideration of all expected load conditions

The operational requirements specified in the Technical Rules should be specified in a manner that caters for all expected load conditions.

8.10.1 Current issue

Clause 5.4.1(b) in the current Technical Rules defines the obligations on the Network Service Provider to control voltage. This clause refers specifically to the need to assess the ability to “avoid voltage failure or collapse”. While preventing voltage collapse is a legitimate concern when considering the adequacy of voltage control, a focus on voltage collapse tends to focus on consideration of peak demand conditions. The drafting may be interpreted as requiring less focus on other demand conditions.

The continued uptake of distributed energy resources such as rooftop PV systems is making control of voltage during light load periods challenging. It is, therefore, appropriate to consider revisions that avoid any undue focus on any one demand condition.

8.10.2 Solution options & preferred solution

Western Power considered the following options to address the issue:

a) Amend clause 5.4.2(b) to replace the words focussing on voltage collapse with a broader requirement to monitor voltages and implement operational arrangements to maintain voltage within the operational voltage envelope specified by AEMO and the voltages limits specified in the powers system performance standards (i.e., clause 2.2 of the Technical Rules)

b) No change.

Option a) is recommended as it avoids any interpretation that voltage issues need only be considered under peak demand conditions.

9. Attachments and other changes

Several changes are proposed that address issues spanning multiple sections or chapters of the Technical Rules. These changes are typically not material in nature and include updates to references, Glossary terms and explanations of structural changes.

Proposed changes to Attachments are also covered in this section.

9.1 Attachments

Attachments to the Technical Rules provide additional information and guidance. Changes proposed to the Attachments are summarised in Table 9-1. In most cases, changes are minor and proposed to address grammar, style and referencing matters. In some cases, changes to the titles of attachments are proposed for consistency and to reflect updated coverage.

Several changes are proposed to introduce new data requirements for generators. The additional data is required by the Network Service Provider to evaluate the effect of the generators on the power system. Changes are consistent with requirements under the NER (and the WEM Rules) and provide a more consistent coverage of generation technologies typically connected to the SWIS.

One new attachment is proposed to support the revised transmission system planning criteria. This attachment provides guidance on the economic considerations and justification needed for the investment in transmission infrastructure when designed to a higher or lower standard than outlined in the new transmission system planning

Table 9-1: Summary of proposed amendments to attachments to the Technical Rules

Attachment	Proposed changes
Attachment 1: Glossary	• Updates to defined terms consistent with proposed changes outlined in this submission • Minor and consequential changes (as outlined in section 9.3)
Attachment 2: Interpretation	• No change
Attachment 3: Schedules of technical details in support of connection applications	• Minor and consequential changes
Attachment 4: Large generating unit design data	• Structural changes to reorder requirements • Minimum short circuit ratio requirements (consistent with chapter 2 and 3 changes) • Data on power quality characteristics for wind generators (consistent with chapter 3 changes) • Data for inverter connected generating systems – consistent with existing requirements in the Attachment that apply to small generators
Attachment 5: Submission requirements for electrical plant protection	• No change
Attachment 6: Large generating unit setting data	• Updated title
Attachment 7: Transmission system and equipment technical data of equipment at or near connection point	• Grammatical changes

Attachment	Proposed changes
Attachment 8: Transmission system equipment and apparatus setting data	• No change
Attachment 9: Load characteristics at connection point	• Minimum short circuit ratio requirements (consistent with chapter 2 and 3 changes)
Attachment 10: Distribution system connected generators up to 10 MW (except invertor-connected generators up to 30 KVA)	• Updated title • Allowance for the Network Service Provider to require data on power quality characteristics for inverter connected generators. • Clarity on reactive capacity curve requirements for inverter connected generators
Attachment 11: Test schedule for specific performance verification and model validation	• Minor changes • Adjustments to Figure A11.2 to fix where formatting errors had hidden parts of diagram
Attachment 12: Testing and commissioning of small power stations connected to the distribution system	• Minor changes
(new) Attachment 13: Guidance on economic justification	• Developed to support the proposed transmission system planning criteria

9.2 Typographic and editorial changes

In reviewing the Technical Rules, Western Power has identified and proposed several minor typographic editorial changes. Changes include:

- Spelling and grammatical corrections,
- Stylistic changes such as updates to formatting of diagrams, tables, headers, footers and the title page,
- Cross-referencing corrections, and
- Formatting changes to correctly identify terms where they are defined (and the definition is intended to be used).

These updates are not material, so they have not been separately identified in this submission. Minor corrections primarily improve the readability of the document.

Of note, consistent with changes to the Australian Standard references to 'VAr' have been updated to 'var' throughout the proposed Technical Rules.

9.3 Glossary updates

Terms in the Glossary of the Technical Rules have been updated to align with proposed changes outlined in the remainder of this document. When considering these updates, Western Power has considered the ideal outcome of aligning with the Act, the Access Code and the WEM Rules.

In addition to individual changes discussed elsewhere in this document, Western Power proposes changes to the Glossary to:

- Remove redundant terms that are no longer referenced in the document. Western Power notes some definitions have been retained despite these no longer being used as these are key terms used in various supporting documents and procedures.

- Demote generic terms where the use of a specific definition is not needed and could cause inaccuracies due to the high risk of stylistic errors (i.e., the term could accidentally be italicised). For example, the term ‘equipment’ is defined as ‘a device used in generating, transmitting or utilising electrical energy or making available electric power.’ The term is used when this meaning is intended but also many times when a more generalised use of the term is meant. The clause context is sufficient for readers to understand what definition of equipment is meant as such Western Power proposes no longer referring to this as a defined term.
- Update definitions to align with changes in definitions of associated terms.
- Reinsert definitions where definitions refer to other regulatory instruments and the definitions no longer appear in those instruments. For example, the term ‘access contract’ is given the same meaning as the Act, but this term is not used in the Act. The term is defined in the Access Code, so it is proposed that this definition apply.
- Moved definitions from clauses into the Glossary to allow for more consistent use of the moved definitions and facilitate referencing. For example, a definition for ‘reasonably foreseeable load’ is provided in clause 2.6(a) of the Technical Rules, and this has now been moved to the Glossary.
- Make minor amendments to improve the consistency of language and style.

These updates to the Glossary do not change the intended meaning of the terms and do not alter the requirements expressed in the Technical Rules, so they have not been separately identified in this proposal. The proposed Glossary changes primarily improve the readability of the document.

9.4 Update references to System Management

The Technical Rules were drafted when the System Management function was part of Western Power and covered by the Access Code. The role of System Management is now undertaken by AEMO, and it is no longer appropriate for the Technical Rules to refer to System Management or place obligations on AEMO in this capacity.

Western Power proposes changes to update or remove references to System Management. Changes fall into one of two categories:

1. Where the Technical Rules place a direct obligation on System Management, this has been updated to remove the requirement.

   AEMO’s obligations are outlined in the Electricity Industry Act, the WEM Rules and other regulatory instruments. The Access Code (under the Electricity Industry Act) gives authorisation for the Technical Rules, and the Access Code does not provide for obligations on AEMO.

   In removing direct obligation on System Management from the Technical Rules, Western Power has considered whether the provision should be deleted entirely, replaced with a passive role for AEMO (for example, being notified of a change or afforded the opportunity to comment) or replaced with a role for the Network Services Provider and proposed updates accordingly.
2. Where the Technical Rules allow for a passive role for System Management, changes either:
   a. Remove the provision if the role is no longer needed
   b. Update the provision to refer to AEMO if the role is still required

   AEMO has an important role in managing power system security and reliability. It is appropriate for AEMO to continue to be notified and have the opportunity (but not obligation) to comment on matters that involve power system security and reliability.

Given the significant number of references to System Management in the current Technical Rules, proposed changes are not separately identified in this proposal. AEMO was involved in the workshops when the above principles for change were discussed and reviewed draft proposed changes before submission of this rule change request.

As discussed in section 2.2 of this submission, revisions have been proposed to clause 1.3(b)(2) of the Technical Rules that identify that the role of AEMO is defined in the WEM Rules. The retention of the reference to AEMO in this clause does not place any obligations on AEMO. Rather, it clarifies for all users that AEMO has a role within the Technical Rules context.

9.5 References to operating states

The Technical Rules currently refers to a 'normal operating state' as defined in Table 9-2. The term is used both as a non-defined and defined term (i.e., italics is not always used). A reliable operating state is also used when referring to the operation of the power system but is not defined.

Table 9-2: Operating state definitions

Term	Definition
normal operating state	Characterises operation when all significant elements of a *transmission system* are in service and operation is within the secure *technical envelope*

9.5.1 Current issue

The WEM Rules uses defined operating states to describe states or modes of operation of the power system. At the time of this submission, Chapter 11 of the WEM Rules[65] defines operating states as follows:

- Normal Operating State: The state of the SWIS defined in clause 3.3.1 [of the WEM Rules].
- High Risk Operating State: High Risk Operating State: The state of the SWIS described in clause 3.4 [of the WEM Rules].
- Emergency Operating State: Emergency Operating State: The state of the SWIS defined in clause 3.5.1 [of the WEM Rules].

However, these terms have recently been reviewed and expected to be amended to separate the power system reliability standards in the SWIS. Amendments planned for the WEM Rules will remove the above definitions and adopt newly defined states: 'reliability operating state', 'satisfactory operating state; and 'secure operating state'.[66]

The use of the term normal operating state in the Technical Rules should be reviewed to ensure appropriate alignment with the updated state definitions that will be adopted in the WEM Rules. This will avoid confusion and ensure the power system is planned and managed by Western Power in a consistent manner with the WEM Rules.

9.5.2 Solution options & preferred solution

Western Power considered the following options to address the above issues:

a) Update the Technical Rules to refer to the operating states newly defined in the WEM Rules and include Glossary definitions that refer to the WEM Rule definitions.

[65] Wholesale Electricity Market Rules, 1 February 2021

[66] Tranche 2 Amending Rules, as published on 16 October 2020. [is the

b) Remove all references to operating states and use alternative terminology. For example, refer to 'normal operating conditions' as an undefined term instead of 'normal operating state' in clauses where a description of the system operating within normal limits is needed.

c) No change. Operating state definitions in the Technical Rules are independent of those proposed for the WEM Rules.

Western Power proposed changes consistent with option b). Significant consideration was given to adopting the WEM Rule definitions and modifying Technical Rules drafting – particularly for the transmission planning criteria in section 2.5 and for the transmission and distribution operating and coordination provisions in Chapter 5. The revised operating state definitions proposed for the WEM rules are not readily applied in the Technical Rules as the Technical Rules needs to address both planning and operational timeframes. The operating states defined in the WEM Rules are primarily used to define the framework and approach for managing power system security in operational timeframes. The review of the Technical Rules identified that roles and responsibilities could be adequately defined without reference to the operating states defined in the WEM Rules.

Option c) is not preferred because any misaligned use of terms referring to operating states in the Technical Rules and WEM Rules is potentially confusing.

9.6 Updated Australian Standards

The Technical Rules leverage international and Australian Standards when specifying technical requirements. Australian Standards are typically preferred in the first instance, and international standards are used where an equivalent Australian Standard does not exist or is not suitable. Referencing standards helps ensure alignment with practice in other jurisdictions and reduces the specifications needed in the Rules.

As part of the Technical Rules review, Western Power reviewed the standards referred to and considered if the current referencing was appropriate. In some instances, the standard was no longer appropriate, or the proposed drafting changes meant the standard reference was no longer needed. AS/NZS 60044 is no longer referred to in the Technical Rules.

In other cases, it was appropriate to retain the reference. However, the international and Australian Standards have been updated since the reference in the Technical Rules was introduced. As part of the Technical Rules review, Western Power reviewed each standard referred to and whether that standard had been updated. For each reference, Western Power considered whether references to standards should be:

- Maintained and continue to refer to the superseded standard.
- Updated to refer to the updated standard.
- Revised to omit the year of the standard, thereby providing for an automatic update mechanism when and if the standard is updated.

Western Power has proposed changes that seek to minimise costs to Users (e.g., retaining the existing standard or moving to the new standard where relevant clauses in the standard have changed), while making updates that reflect technology changes and, if required, to facilitate meeting the power system requirements.

Table 9-3 summarises the standards referred to in the revised Technical Rules. It lists for each standard: the version referenced in the proposed Technical Rules, the year of the most recent version of the standards and whether the standard remains relevant in the context of the Technical Rules. Where the version referenced in the Technical Rules is not the most recent version this reflects an assessment by Western Power that some aspects of the historical standard need to be referred to in the Technical Rules.

In most cases, the Technical Rules do not refer to a version and where this is the case, Western Power considers it appropriate to maintain that convention. Where updated standards are available, Western Power has considered if the revised standard can be adopted and made changes to the relevant clauses consistent with the rationale provided above.

Table 9-3: Standards referred to the in Technical Rules

Standard	Version referenced in the proposed Technical Rules (prior to the update of the standard version)	Most recent version of the standard
AS 1359.101	None	1998
AS 3851 (1991) (Amendment 1-1992)	1991	1991
AS 60947.6.2	2004	2015
AS/NZS 2067	None	2016
AS/NZS 2344	2016	2016
AS/NZS 3000	None	2018
AS/NZS 4777	None	2020
AS/NZS 4777.2	None	2020
AS/NZS 5033	None	2014
AS/NZS 61000.3.100	2001	2011
AS/NZS 61000.3.6	2001	2012
AS/NZS 61000.3.7	2001	2012
AS/NZS 61000.4.7	1999	2012
IEC 60034-1	None	2017
IEC 60255	None	2009
IEC 61400-21	None	2019
IEC 61869	None	2007
IEEE 115-1983 - Test Procedures for Synchronous Machines	1983	2019

9.7 Structure of Technical Rules and retention of historical numbering

The Technical Rules review has resulted in Western Power proposing substantial changes to the drafting throughout the Technical Rules. Various sections in this submission discuss the specific structural changes proposed for the various chapters of the Technical Rules. In developing those changes, Western Power considered a number of alternatives and the impact of the proposed change. The aim being to validate that the added clarity delivered by the proposed change outweighed any additional effort required to adjust to the new structure and changes to historical clause references.

9.7.1 Structure changes

Structure changes are proposed to the Technical Rules for the following:

- Separation of the transmission and distribution system planning criteria. The adoption of a more flexible and full coverage transmission system planning criteria necessitated the separation of some clauses that were previously relevant to both transmission and distribution system planning. While several clauses are retained from the 2016 version of the Rules that pertain to both, the separation of the two planning criteria is clearer. Some clauses were recast to fit into the newly separated sections as a consequence of the new structure.
- More clearly differentiating performance standards for the transmission and distribution system voltages and preserving appropriate alignment with the WEM Rules as set out in section 3.1
- Grouping of the protection requirements for Users into a single section as discussed in section 6.8.1.
- Rearranging User requirements in chapter 3 to better clarify the requirements applicable to particular facilities as discussed in section 6.1.1 and through section 6 of this submission.
- Restructure of Chapter 5 to reflect clarified TNO and DNO roles as outlined in section 8.1 of this submission.
-

For each of the above structure changes, Western Power considered the merits of alternative drafting arrangements. On balance, Western Power considers the proposed structure changes promote clarity and are suitable for the adoption of future Technical Rule updates in response to foreseeable future policy and market governance changes (such as the creation of a Distribution System Operator role).

9.7.2 Retention of historic numbering

Western Power considered proposing changes to the Technical Rules that retain historical clause numbering. Such an approach would be consistent with the way the WEM Rules and the NER are updated, where the numbering for deleted clauses is retained, and new clauses are added either at the end of existing lists or with alphabetical suffixes if inserted mid-list.

Retention of historical clause references has some advantages:

- References to supporting documents such as procedures, processes and guidelines require less updating (to the extent that clauses have not been deleted).
- Where reference is made to a clause that has been replaced, there is no confusion as to whether the replacement text applies (because the newest version of the rules simply states 'deleted', and the reader is prompted to go to a historical version).

However, there are also disadvantages of such an approach:

- The document becomes lengthy and convoluted, making it difficult to understand what the requirements are.
- Updates may be more complex because drafting is piecemeal.

On balance, Western Power considered it appropriate to propose changes that offer a completely refreshed, clean version of the Technical Rules. The proposed changes are sufficiently substantive that procedures and processes with Western Power that refer to the Technical Rules clauses will need to be reviewed regardless of clause numbering.

Connection agreements for Users reference the version of the Technical Rules that applies to their facilities. Historic versions of the Technical Rules are maintained on the ERA website and may be readily referenced as needed to support the interpretation of connection agreements.

9.8 Coverage of new and emerging technologies

The Technical Rules do not necessarily contemplate or provide sufficient guidance for the adoption of new and emerging technologies, both with respect to how Western Power should treat them under the planning process and as part of potential solution options as alternatives to traditional network investment options. Further, the application of connection requirements for Users is potentially confusing where newer technology is concerned (for example, application of clauses to energy storage is not clear).

New and emerging technologies include forms of electricity and energy storage systems as well as network technological developments related to traditional plant (for example, overhead lines, underground cables, substation switchgear).

In reviewing the Technical Rules, Western Power considered if direction was required within the Technical Rules to account for new and emerging technology solutions, including those that can connect directly to the SWIS or be used by Western Power as alternatives to traditional investment solutions. For example, should Technical Rules be amended to detail how apply specific technologies should be treated? Alternatively, should a more structured approach be adopted based on the underlying characteristics of equipment, for example, battery energy storage systems could be dealt with as both demand and generator?

Western Power considers the Technical Rules should be as technology neutral as possible. This is achieved by focusing on the underlying technical requirements that support efficiently meeting power system performance requirements.

Clauses in the Technical Rules have been reviewed to align with this approach and avoid unnecessarily restricting or limiting the application of new technologies, solutions or concepts. This is achieved by minimising explicit naming or reference to individual technologies beyond what is necessary to describe characteristics, requirements or obligations. This is further discussed is section 6.1 of this submission.

The following sections outline considerations given to particular concepts and technologies.

9.8.1 Virtual power plants or aggregated DER

Virtual power plants are typically cloud-based IT systems that aggregate the capacities of distributed energy resources (DER)[67]. In Western Australia, virtual power plants (also referred to as aggregated DER) are described in the DER Roadmap as “notional entities comprised of aggregated and controlled DER components that can provide generation and system support functions and participate in energy markets (like traditional generators)”.[68]

The rise of virtual power plants in Western Australia is expected to change the incentives faced by DER and the financial flows between parties. However, the existence of virtual power plants does not alter the

[67] Distributed energy resources, or ‘DER’, are smaller–scale devices that can either use, generate, or store electricity and form a part of the local distribution system, which serves homes and businesses. DER can include renewable generation, energy storage, electric vehicles (EVs), and technology to manage load at the premises. These resources operate for the purpose of supplying all or a portion of the customer’s electric load and may also be capable of supplying power into the system or alternatively providing a load management service for customers Source: Energy Policy WA, *Distributed Energy Resources Roadmap*, April 2020, p. 77. Available at: https://www.wa.gov.au/sites/default/files/2020-04/DER_Roadmap.pdf

[68] Energy Policy WA, *Distributed Energy Resources Roadmap*, April 2020, p. 77. Available at: https://www.wa.gov.au/sites/default/files/2020-04/DER_Roadmap.pdf

requirements that should be placed on the power system or, at this stage, the arrangements for User's connecting to power systems from a physical point of view.

Therefore, assuming that participation in the WEM by aggregators does not change the party responsible for compliance with the Technical Rules:

- Users responsible for facilities or equipment used in aggregation must meet the technical reequipments applicable to those facilities and equipment.

Aggregators may offer services to the Network Service Provider or the market. Western Power notes:

- If the aggregator is providing services to the Network Service Provider under a network support arrangement, then the Network Support Contract may be the appropriate vehicle to specify the relevant performance requirement such as the requirements over the controllability and observability of the service.
- If the aggregator is providing energy market services or ESS procured by AEMO then the aggregate would need to meet applicable performance requirements which may be specified in the WEM Rules or ESS contracts.

The role of aggregators may need to be revisited in the future. Particularly, if collectively, the participation by aggregators in the WEM begins to materially alter the way the power system is operated.

9.8.2 Electrical and energy storage

Electrical storage primarily relates to batteries and their ability to absorb excess energy (charge the battery) and release that energy (discharge the battery) when it is needed to add value by suppling demand and essential system services.

Changes to the *Electricity Industry Act 2004* allowing Western Power to use energy storage devices came into effect on 6 April 2020. While these changes allow Western Power to more freely deploy and utilise this technology, the Technical Rules did not require specific amendment to accommodate the use of Energy Storage to meeting the transmission and distribution planning criteria.

As discussed in section 6.1 of this submission, revisions have been proposed to the User requirements to clarify those requirements that apply to electrical storage systems installed within User facilities.

9.8.3 Embedded networks

Embedded networks are private electricity networks that serve multiple premises and are located behind the same connect point to the distribution or transmission system.[69]

The Technical Rules are primarily concerned with the operation of the broader power system and the parts of the network that Western Power owns and operates. While the activities of customers and network elements behind a connection point will flow through to the wider electricity distribution and transmission systems, the focus of the Technical Rules is on the point of connection at that parent connection point. As such, Western Power is not proposing any new or different requirements for these systems in the current rule change request.

[69] Energy Policy WA, *Distributed Energy Resources Roadmap*, April 2020, p.77. Available at: https://www.wa.gov.au/sites/default/files/2020-04/DER_Roadmap.pdf

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