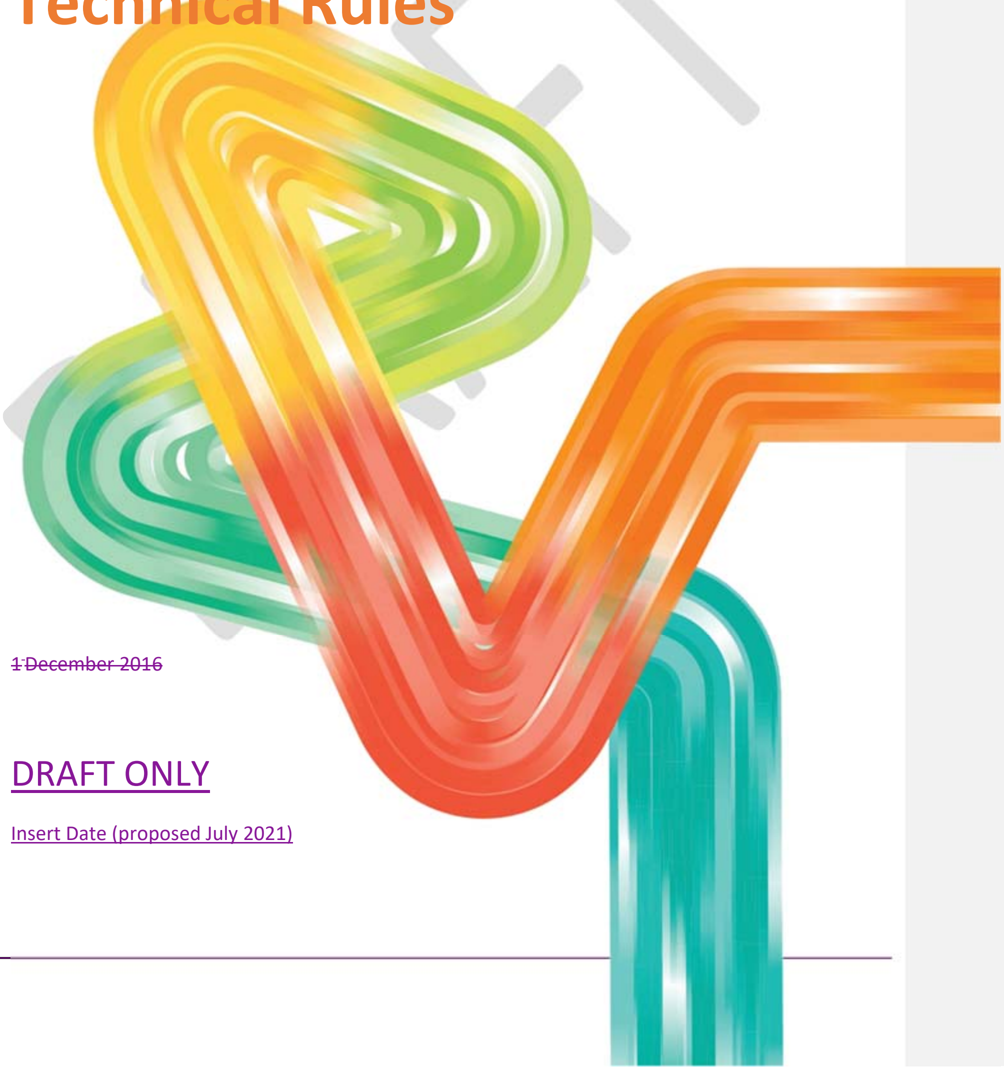
Technical Rules



~~1 December 2016~~

DRAFT ONLY

Insert Date (proposed July 2021)

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* and *stand-alone power 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* ~~(*NSPs*).~~.

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

1) Western Power, and

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

Prospective *Users* or existing *Users* who wish to connect *facilities* (or modify existing connections) to the *transmission and distribution systems*, *disconnected microgrids* or *stand-alone power 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 ~~*Rules*~~*Rule* requirements granted to *Users* and ~~or *NSPs*~~the *Network Service Provider*, can only be made in accordance with the *Access Code*.

~~1 DECEMBER 2016,~~[INSERT DATE], Revision ~~3~~x (DRAFT)

This *revision* of the Technical Rules contains amendments approved by the *Authority* decision of ~~9 November 2016.~~[insert date]. That decision relates to amendments proposed by Western Power in ~~March and April 2016,~~[insert date], and the approved amendments apply from ~~1 December 2016.~~[insert date].

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

~~Revision 3 date 17 January, 2017 (see amendments and revisions table p. 169).~~

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1. *GENERAL*

1.1 INTRODUCTION

(a) ~~This section 1~~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 ~~methodology~~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*. ~~They~~As applicable, they set out:

(a) the required performance standards for service quality in relation to the *power system, disconnected microgrids, and stand-alone power systems*;

(b) the technical requirements for the design or operation of equipment *connected* to the *transmission and distribution systems*~~;~~*, disconnected microgrids, and stand-alone power systems;*

(c) the requirements for the operation of the *transmission and distribution systems* ~~(including the operation of the *transmission*~~*, disconnected microgrids,* and ~~*distribution*~~*stand-alone power systems* ~~in emergency situations or where there is a possibility of a person suffering injury but~~ excluding the operation of those parts of the *transmission system* under the control of ~~*System Management*~~*AEMO* acting in accordance with the ~~*Market*~~*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 ~~which~~that apply if the *Network Service Provider* believes that a ~~*User's*~~*User's* equipment does not comply with the requirements of these *Rules*;

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

(g) the procedures for system tests carried out in relation to all or any part of the *transmission and distribution systems*~~;~~*, disconnected microgrids, and stand-alone power systems;*

(h) the requirements for control and *protection* settings for equipment *connected* to the *transmission and distribution systems*;, *disconnected microgrids*, and *stand-alone power systems*;

(i) the procedures for the commissioning and testing of new equipment *connected* to the *transmission and distribution systems*;, *disconnected microgrids*, and *stand-alone power systems*;

(j) the procedures for the disconnection of equipment from the *transmission and distribution systems*;, *disconnected microgrids*, and *stand-alone power systems*;

(k) the procedures for the operation of *generation* that is not under the control of *System Management*AEMO but which is *connected*, either directly or indirectly, to the *transmission* orand *distribution* systemsystems, *disconnected microgrids*, and *stand-alone power 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*, *disconnected microgrids*, and *stand-alone power systems* at the *User's* *connection point* and how and when that information is to be provided;

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

(n) other matters relating to the *transmission and distribution systems*, *disconnected microgrids*, and *stand-alone power systems* or equipment *connected* directly or indirectly to the *transmission and distribution* systems, *disconnected microgrids*, or *stand-alone power* *systems*; and

(o) the network planning criteria for *transmission and distribution systems* as required by section A6.1(m) of the *Access Code*, *disconnected microgrids*, and *stand-alone power 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) but, for the purpose of these *Rules* does not include System Management.).

(b) These *Rules* apply to:

(1) the *Network Service Provider* in its role as the owner and *operator* of the *transmission and distribution systems*;, *disconnected microgrids*, and *stand-alone power systems*;

(2) System ManagementAEMO 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*, *disconnected microgrids* or *stand-alone power systems* 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*, *disconnected microgrids* or *stand-alone power systems* 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* and*or* *distribution* *system*, a *disconnected microgrid* or *stand-alone power 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 *Revisionrevision* is the date on the cover page unless otherwise indicated.

1.5 INTERPRETATION

(a) In these *Rules*, the words and phrases defined in Attachment 1Attachment 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 1Attachment 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 ensure 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*, ~~*System Management*~~*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*, ~~*System Management*~~*AEMO* or *User* is not taken to have breached such obligation imposed under these *Rules* provided the *Network Service Provider*, ~~*System Management*~~*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) ensure that, for *connection points* on the *transmission* ~~and~~or *distribution system, disconnected microgrids*, and *stand-alone power systems*~~,~~ 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 ~~which is to be *connected* to the *transmission system*~~ 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; ~~and~~

(5) ensure 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~~, where there are grounds to question the validity of data.~~;

(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*, *disconnected microgrids, and stand-alone power systems* such that~~-~~:

~~(1)~~(A) when the *power system* is ~~in the~~under normal operating ~~*state*~~conditions electricity may be transferred continuously at a *connection point* up to the *agreed capability* of that *connection point*;

~~(2)~~(B) ~~management, maintenance and operation of the *transmission and distribution systems* to minimise~~ the number and impact of interruptions or service level reductions to *Users*~~; and~~ is minimised;

~~(3)~~(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 ~~THE~~THESE RULES

1.9.1 *User* ~~*Exemptions*~~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 ~~the operation or security of the~~ *power system security or power system reliability*, the *Network Service Provider* must consult with ~~the *Independent Market Operator* and/or *System Management*~~*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) ~~*Network Service Provider* Exemptions~~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.~~54~~54A of the *Access Code*.

~~(b) Where a *User* can demonstrate that an International or Australian Standard, which is not specified in these *Rules,* has equal or more onerous requirements to a specified Standard, the *Network Service Provider* must submit a proposal to the *Authority,* in accordance with the requirements of section 12.50 of the *Access Code,* to amend the *Rules* to include the proposed Standard. The submission must 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.~~

~~1.9.4 Transmission and Distribution Systems and Facilities Existing at 1 July 2007~~

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 system*, a *disconnected microgrid* or a *stand-alone power system;* 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.

~~(b)~~(c) When equipment ~~covered by clause 1.9.4(a)~~ is upgraded or modified for any reason, the ~~modified or~~ 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 ~~existed at the *Rules commencement date* and that~~ forms ~~part~~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~~ suitability with the *Rules*

(a) A *User* or the *Network Service Provider* ~~whose *equipment* is deemed by clause 1.9.4 to comply with the requirements of these *Rules*~~ must ensure that the capabilities and ratings of that equipment ~~are~~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 section 2This 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* Variationsvariations

(a) The nominal operating *frequency* of the *power system* is 50 Hz.

(b) The *accumulated synchronous time error* must be less than 10 seconds for 99% of the time.

(c) The frequency operating standards specified in the *WEM Rules* apply for the *power system* are summarised in Table 2.1.

(a) **Table 2.1 *Frequency***when it is operating ***standards for the South West Interconnected Network***as a single interconnected system or as one or more islanded systems created by disconnecting one or more *transmission elements*.

Condition	Frequency Band	Target Recovery Time
Normal Range:		
South West	49.8 to 50.2 Hz for 99% of the time	
Island[1]	49.5 to 50.5 Hz	
Single contingency event	48.75 to 51 Hz	Normal Range: within 15 minutes. For over-*frequency* events: below 50.5 Hz within 2 minutes
Multiple contingency event	47.0 to 52.0 Hz	Normal Range within 15 minutes For under-*frequency* events: (a) above 47.5 Hz within 10 seconds (b) above 48.0 Hz within 5 minutes (c) above 48.5 Hz within 15 minutes. For over-*frequency* events:

~~Condition~~	~~Frequency Band~~	~~Target Recovery Time~~
		~~(d) below 51.5 Hz within 1 minute~~ ~~(e) below 51.0 Hz within 2 minutes~~ ~~(f) below 50.5 Hz within 5 minutes~~

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*.

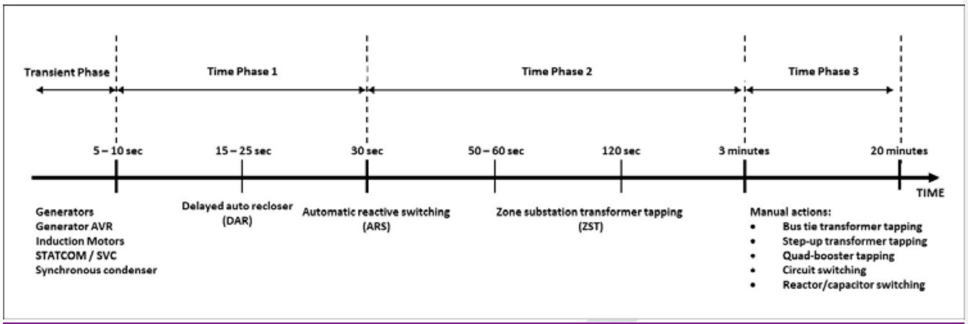

Figure 2-1 Timeframes for the assessment of *voltage* performance

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* assessed 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.

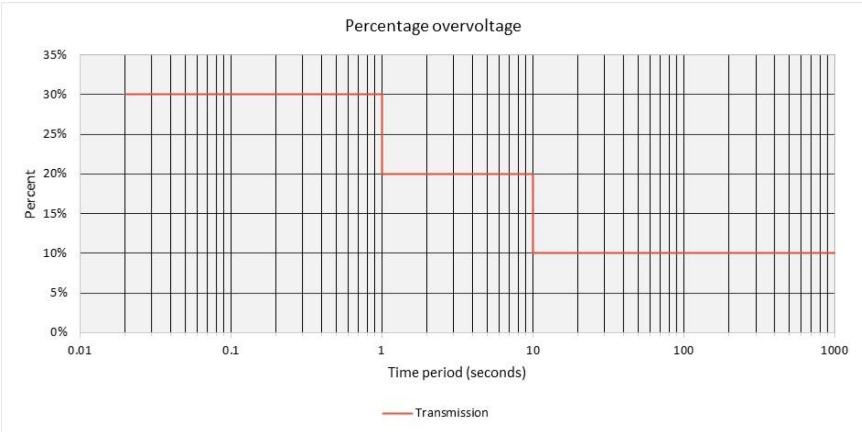

Figure 2-2 Highest acceptable level and duration of AC transient overvoltage on the *transmission system*

Note:

(d) The *frequency operating standards* must be satisfied, provided that there is no shortage of *spinning reserve* in accordance with clause 3.10.2 of the *Market Rules*, without the use of *load shedding* under all credible *power system load* and *generation* patterns and the most severe *credible contingency event*.

(e) In the event of a loss of interconnecting *equipment* leading to the formation of an island separate from the rest of the *power system, load shedding facilities* within the island may be used to ensure that the *frequency operating standards* specified in Table 2.1 are satisfied within the islanded part of the *power system*. Once the *power system* within the island has returned to a steady state operating condition, the "island" *frequency* range in Table 2.1 will apply until the islanded *power system* is resynchronised to the main *power system*.

(f) *Load shedding facilities* (described in clause 2.3.2) may be used to ensure compliance with the *frequency operating standards* prescribed in Table 2.1 following a multiple *contingency event*.

2.2.2 Steady State Power *Frequency Voltage*

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) Where there is sufficient economic justification and no *Users* of the system are adversely affected then, 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.

(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* ~~*event*~~, the minimum *steady state voltage* on ~~the *transmission system* and~~ those parts of the *distribution system* operating at *voltages* ~~of 6 kV and~~ above 1 kV must be 90% of nominal *voltage* and the maximum *steady state voltage* must be 110% of nominal *voltage*. ~~For those parts of the *distribution system* operating below *voltages* of 6 kV, the steady state *voltage* must be within:~~

~~(1)~~ ~~± 6% of~~For the ~~nominal~~*low voltage* ~~during *normal operating*~~*distribution system*, the *steady state*~~,~~

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

(b) ~~±10% of~~must remain within the ~~nominal~~limits specified in Table 2-4 with those limits derived from AS 61000.3.100 (2011).

~~(3)~~ **Table 2-4 *Low voltage*** ~~*during emergency conditions.*~~

(b) Step *changes* in ***distribution system*** ***steady state voltage*** levels resulting from switching operations must not exceed the limits given in Table 2.2.

~~Table 2.2 Step - change *voltage* limits~~limits

		~~Pre-switching (quasi steady-state) and during tap-changing~~		~~Post-switching (final steady state)~~	
				~~Transmission~~	~~Distribution~~
~~U_{dyn}[3]/U_N[4] (%)~~	~~*Transmission voltages* must be between 110% and 90% of nominal *voltage*~~Phase-to-Ph[ase] *voltage* (for balanced 3 phase network)				
	456 V	~~Distribution~~	~~Transm~~[ission]		
	~~r ≤ 1~~440 V	~~±.4.0%~~	~~±3.0~~[%]		
	~~1 < r ≤ 10~~376 V	~~±3.0%~~	~~±2.5%~~		
	~~10 < r ≤ 100~~360 V	~~±2.0%~~	~~±1.5%~~		
	~~100 < r ≤ 1000~~		~~±1.25 %~~	~~±1. 0%~~	
~~*Transmission voltages* must be between 110% and 90% of nominal *voltage*~~Vx% is the xth percentile of the *steady state voltage* measured in accordance with AS 6100.3.100 - 2011					

~~**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*.~~

(c) Where more precise control of the *distribution voltage* is required than is provided for under this clause ~~2.2.2(a),~~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*. ~~This may include different target ranges under normal and post-contingency conditions (and how these may vary with *load*). Where~~ Where:

~~(c)~~(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*~~. Where *voltage* magnitude targets are specified in a *connection agreement, Users* should allow for short-time variations within 5% of the target values in the design of their *equipment*.~~;

(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 2-5 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 units within *User facilities.*

Table 2-5 *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.

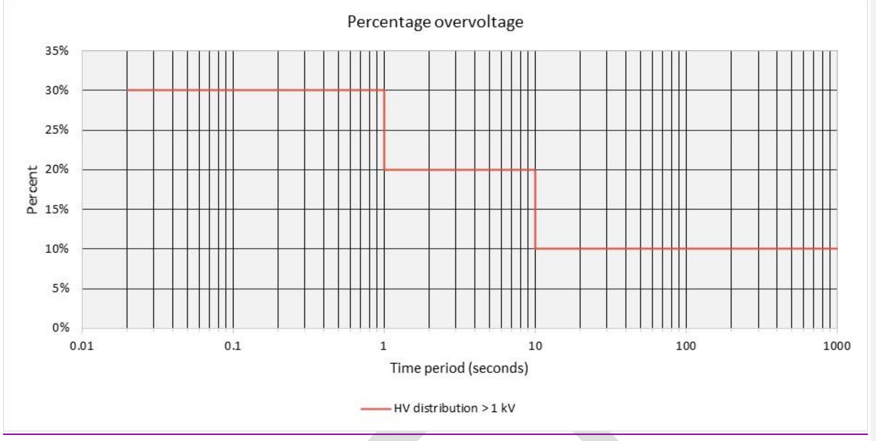

Figure 2-3 Highest acceptable level and duration of AC transient overvoltage on the *distribution system* operating above 1 kV

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*.

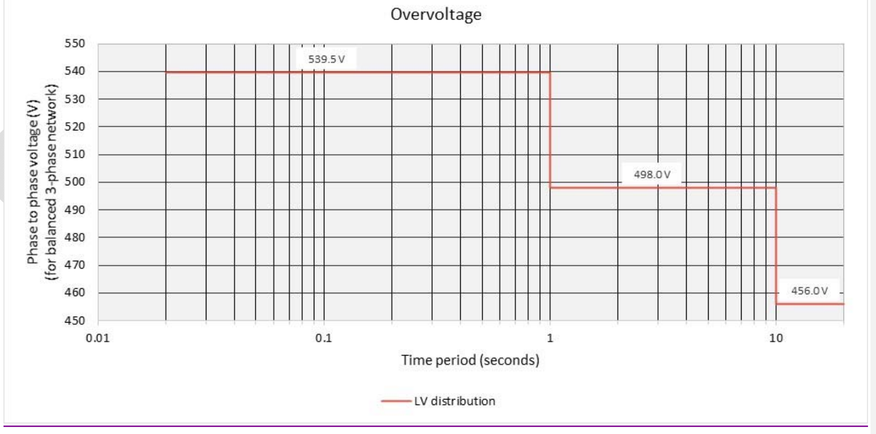

Figure 2-4 Highest acceptable level and duration of AC transient overvoltage on the *low voltage distribution system*

~~2.2.3~~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 2-6 for 99% of the time.

Table 2.-6 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 2.3 are not intended to apply to flicker arising from *contingency* and other *uncontrollable* events in the *power system*, etc.~~

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 2-6 are not intended to apply to flicker arising from *contingency events* and other uncontrollable events in the *power system*, etc.

~~2.2.4~~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 2.4 and Table 2.5~~Table 2-7 and Table 2-8 (as applicable) appropriate to the *voltage* level, whereas the interharmonics *voltage* must not exceed the planning levels ~~of~~set out in *AS*/NZS 61000.3.6 (2001).

Table 2.-7 *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	$0.2 + 0.5\frac{25}{h}$ $0.2 + 0.5\frac{25}{h}$				
Total harmonic distortion (THD): 6.5 %					

Table 2.-8 *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	$0.2 + 0.5\frac{25}{h}$ $0.2 + 0.5\frac{25}{h}$				
Total harmonic distortion (THD): 3 %					

Notes:

1. The planning levels in ~~Table 2.4~~Table 2-7 and ~~Table 2.5~~Table 2-8 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 = harmonic *voltage* of order *h* expressed in percent of the nominal *voltage*.

3. ~~Table 2.4~~Table 2-7 and ~~Table 2.5~~Table 2-8 are consistent with AS 61000 (2001).

~~2.2.5~~2.2.6 Negative ~~Phase Sequence *Voltage*~~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 2.6.~~Table 2-9.

Table 2.-9 Limits for negative phase sequence component of *voltage* (in percent of the positive phase sequence component)

Nominal ~~*System Voltage* (kV~~*system voltage* (kv)	Negative ~~*Sequence Voltage*~~sequence *voltage* (%)
> 100	1
10 – 100	1.5
< 10	2

~~2.2.6~~2.2.7 Electromagnetic ~~Interference~~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 ~~*Australian Standard* AS2344 (1997~~*AS/NZS 2344 (2016)*).

~~2.2.7~~2.2.8 Transient ~~Rotor Angle Stability~~stability

~~All generating units connected to~~ The *power system* must be planned to ensure disturbances on the *transmission* ~~system and generating units within power stations that are connected to the~~ *or distribution* ~~system and that have a total rated output of 10 MW or more must remain in synchronism~~*systems* caused by a *credible contingency*, following a *credible* ~~contingency~~*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.

2.2.82.2.9 Oscillatory Rotor Angle Stabilitystability

(a) System oscillations originating from system electro-mechanical characteristics, electro-magnetic effect or non-linearity of system components, andThe *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* in shall conform to the *power system*, must remain within the *small disturbance rotor angle stability* criteria and the *power system* must return to a stable operating state following the disturbance. The *small disturbance rotor angle stability* criteria are: criteria:

(a)(1) Thethe *damping ratio* of electromechanical oscillations must be the oscillation be at least 0.1.;

(b) For electro-mechanical oscillations as a result of a *small disturbance*, the *damping ratio* of the oscillation must be at least 0.5.

(2) In addition to the requirements of clauses 2.2.8(a) and 2.2.8(b), the *halving time* of any electro-mechanical oscillationsthe *halving time* of any oscillation not to exceed 5 seconds; and

(3) allow *Generators* 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*.

(c) There must not exceed 5 seconds.

2.2.9 Short Term *Voltage* Stability

(a) Short term *voltage stability* is concerned with the *power system* surviving an initial disturbance and reaching a satisfactory newbe sufficient static and dynamic *reactive power* capability available to maintain *steady state*.

(b) Stable *voltage* control must be maintained following the most severe *credible contingency event*.

2.2.10 Temporary Over-*Voltages*

As a consequence of a *credible contingency event,* the power *frequency voltage* at all locations in the *power system* must remain within the over-voltage envelope shown in Figure 2.1.

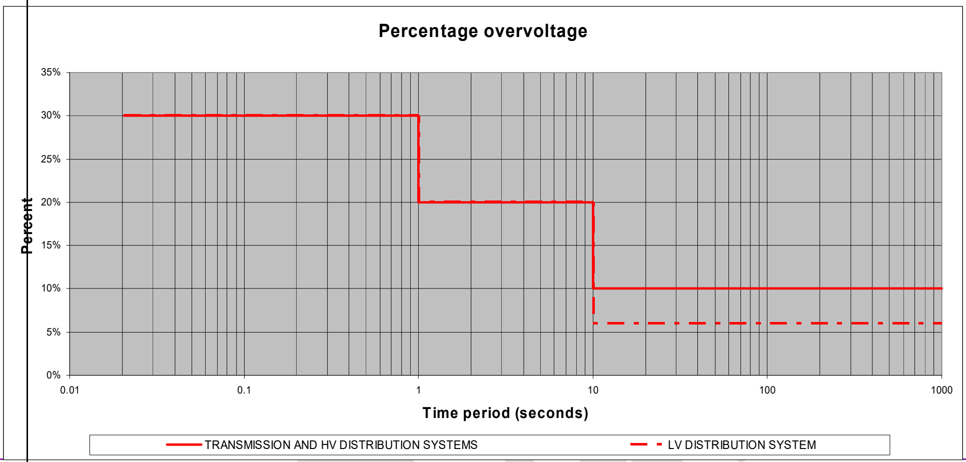

Figure 2.1 Highest acceptable level and duration of AC temporary over*voltage*

allowing for **Note:**
In Figure 2.1 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 0. For the purposes of this clause the *voltage* is the RMS phase to phase *voltage*.

2.2.11 Long Term Voltage Stability

(a) Long term *voltage stability* includes consideration of slow dynamic processes in the *power system* that are characterised by time constants of the order of tens of seconds or minutes.

(b) The long term *voltage stability* criterion is that the *voltage* at all locations in the *power system* must be stable and *controllable* following the most onerous post-contingent system state following the occurrence of any *credible contingency* event under all credible variations in *load* conditions 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 Frequency Control

(a) The *Network Service Provider* must design and install an automatic under *frequency load shedding* system on the *transmission and distribution systems* to ensure that the *frequency* performance of the *power system* following a multiple *contingency event*, as specified in Table 2.1, can be achieved. Further information on the technical requirements of this system is given in clause 2.4.

(b) The automatic under *frequency load shedding* system must be designed to ensure that, should a *contingency event* occur that results in the formation of islands, each island in the *power system* that contains generation has sufficient *load shedding* facilities to aid recovery of the *frequency* to the normal band within the time frames specified in Table 2.1.

(c) The *Network Service Provider* may require commercial and industrial *Consumers* to make a portion of their *load* available for automatic under *frequency* or under voltage *load shedding* or both and may also require a commercial or industrial *Consumer* to provide control and *monitoring equipment* for the *load shedding facilities*. The amount of *load* to be available for shedding and the frequencies or voltages or both at which *load* must be shed must be negotiated between the *Network Service Provider* and the *User* or, failing agreement between them, must be as specified by the *Network Services Provider* consistent with Table 2.8, and must be specified in the relevant *connection agreement*.

2.3.2 *Load* to be Available for *Disconnection*

(a) The *Network Service Provider* must ensure that up to 75% of the *power system load* at any time is available for *disconnection* under any one or more of:

(1) the automatic control of under *frequency* relays;

(2) manual or automatic control from *control centres*; and

(3) the automatic control of undervoltage relays.

(b) To satisfy this overall criterion, the *Network Service Provider* may, at its discretion, arrange for up to 90% of the *power system load* if necessary to ensure that the *frequency* performance standard specified in clause 2.2.1 can be met for all credible *power system load* and *generation* patterns, to be available for automatic *disconnection*. The *Network Service Provider* must advise *Users* if this additional requirement is necessary.

(c) The *Network Service Provider* may install special *load shedding* arrangements to cater for abnormal operating conditions.

(d) Arrangements for *load shedding* must include the opening of circuits in the *distribution system* and may include the opening of circuits in the *transmission system*.

(e) The *Network Service Provider* must use its best endeavours to assign feeders to stages within the *load shedding* system so that *loads* supplying *essential services* are not made available for shedding or are given a lower *load shedding* priority than other *load*.

2.3.32.3.1 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 2.2.32.2.4, 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*/ANZNZS 61000.3.7 (2001).

(c) If the *User* cannot meet the contribution calculated by using the method of clause 2.2.3(b)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*/ANZNZS 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).

2.3.42.3.2 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 2.2.4,2.2.5, 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 *load**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.

2.3.52.3.3 Negative Phase Sequence *Voltage*phase sequence *voltage*

(a) If the maximum level of negative phase sequence *voltage*, as specified in Table 2.6Table 2-9, 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'sUser's* equipment or *facilities,* it must require the *User* to remedy the unbalance.

2.3.62.3.4 Electromagnetic Interferenceinterference

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 justifiedsubstantiated 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 *system* stability and *dynamic performance*

2.3.72.3.5.1 Stability and Dynamic Performancemodelling guidelines

(a) Short Term 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.*

2.3.7.12.3.5.2 Stability and modelling obligations

(a) The *Network Service Provider* must plan, design and construct the *transmission and distribution systems* so that the short term *power system stability* and *dynamic performance* criteria specified in clauses 2.2.7in clauses 2.2.8 to 2.2.102.2.10 are met for credible system *load* and *generation* patterns, and the most critical, for the particular location, *credible contingency event* 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*.

(b)(c) To ensure compliance with clause 2.3.7.1(a)2.3.5.2(a), the *Network Service Provider* must simulate the short term *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'.

(c) Where the simulation of two phase to earth or three phase to earth fault events in accordance with the provisions of clause 2.3.7.1 limits the maximum *power transfer capability* or other relevant operating parameter of a part of the *power system* and this forms the basis for an investment decision which triggers the requirement for a Regulatory Investment Test, the *Network Service Provider* must provide to the Economic Regulation Authority with its submission, information regarding:

(1) the part of the *transmission system* affected;

(2) the *contingency events* modelled;

(3) an overview of the investment decision and the reasons for modelling particular *contingency events*; and

(4) the impact of *contingency events* on the maximum *power transfer capability*.

(d) In planning the *transmission and distribution system*, the *Network Service Provider* must:

(1) assume *a transmission and distribution system* operating configuration with *equipment* out of service for maintenance where this is provided for in the planning criteria specified in clause 2.5; and

(2) use a *total fault clearance time* determined by the slower of the two *protection schemes*, where the *main protection system* includes two *protection schemes*. Where the *main protection system* includes only one *protection scheme*, the back-up *protection system total fault clearance time* must be used for simulations; and

(e) In determining the credible system *load* and *generation* patterns to be assumed for the purpose of short term stability analysis, the *Network Service Provider* must consult with *System Management*. Where practical, and with the agreement of *System Management*, the *Network Service Provider* should set *power transfer* limits for different *power system* conditions, as provided for in clause 2.3.8(a), so as not to unnecessarily restrict the *power transfer* capacity made available to *Users*.

2.3.7.2 Short Term Voltage Stability

(a) The assessment of the compliance of the *transmission and distribution systems* with the different short term *voltage stability* criteria specified in clause 2.2 must be made using simulation of the system response with the best available models of *voltage*-dependent *loads* (including *representative* separate models of motor *loads* where appropriate).

(b) The assessment must be made using simulation of the system response with the short-term overload capability of the *voltage / excitation control system* capability of each *generating unit* or other reactive source represented (magnitude and duration). This is to include representation of the operation and settings of any limiters or other controls that may impact on the performance of *reactive power* sources.

2.3.7.3 Long Term *Voltage* Stability

(a) In assessing the compliance of the *transmission and distribution systems* with the long term *voltage stability* criteria specified in clause 2.2.11, the *Network Service Provider* must first confirm that the *transmission and distribution systems* can survive the initial disturbance.

(b) The long term *voltage stability* analysis must then be carried out by a series of *load*-flow simulations of the *transmission system* and, where necessary, the *distribution system* or by using dedicated long-term dynamics software to ensure that adequate *reactive power* *reserves* are provided within the *transmission and distribution systems* to meet the long term *voltage stability* criteria in clause 2.2.11, for all credible generation patterns and system conditions.

(c) The *Network Service Provider* must model the *power system* for long term stability assessment and transfer limit determination purposes, pursuant to clause 2.3.7.3(b) using the following procedure:

(1) for terminal *substations* in the Perth metropolitan area, 3% of the total installed *capacitor banks* plus the reactive device that has the largest impact on the *power system* must be assumed to be out of service; and

(2) for other areas of the *power system*, including radials:

(A) the normal peak *power system generation* pattern, or other credible *generation* pattern determined by operational experience to be more critical, that provides the lowest level of *voltage* support to the area of interest must be assumed. Of the *generating units* normally in service in the area, the *generating unit* that has the largest impact on that area must be assumed to be out-of-service due to a breakdown or other maintenance requirements. If another *generating unit* is assigned as a back-up, that *generating unit* may be assumed to be brought into service to support the *load* area; and

(B) the largest *capacitor bank*, or the reactive device that has the largest impact in the area, must be assumed to be out-of-service, where the area involves more than one *substation*.

(3) In all situations the *Network Service Provider* must follow the following additional modelling procedures:

(A) all *loads* must be modelled as *constant P & Q loads*;

(B) the *load* or *power transfer* to be used in the study must be assumed to be 5% higher than the expected system *peak load*, or 5% higher than the maximum expected *power transfer* into the area. (The 5% margin includes a safety margin for hot weather, data uncertainty and uncertainty in the simulation). The *power system voltages* must remain within normal limits with this high *load* or *power transfer*;

(C) the analysis must demonstrate that a positive *reactive power reserve* margin is maintained at major *load* points, and that *power system voltages* remain within the normal operating range for this 5% higher *load*; and

(D) *power system* conditions must be checked after the *outage* and both prior to, and following, tap-changing of *transformers*.

2.3.7.42.3.5.3 Validation of Modelling Resultsmodelling 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 2.3.7.1 to 2.3.7.3 and section 32.3.5.2 and Chapter 3 are valid. This may include *power system* and plant performance tests in accordance with clausesection 4.1.

2.3.82.3.6 Determination of *Power Transfer* Limits*power transfer* limits

(a) The *Network Service Provider* must assign, on a request by a *User* or *System Management*,determine *power transfer* limits tofor equipment forming part of the *transmission and distribution systems*.

(a)(b) The assigned *power transfer* limits must ensure that the system performance criteria specified in clause 2.2 are met and may be lower than the *equipment* thermal ratings. Further, the assigned *power transfer* limits may varyexpressed as limits advice developed in accordance with different *power system* operating conditions and, consistent with the requirementsthe procedure defined in clause 2.27A.11 of thesethe *WEM Rules*, should to the extent practicable maximise the *power transfer* capacity made available to *Users* and provided to *AEMO* as specified in the clause 2.27A of the *WEM Rules*.

(b) The *power transfer* assessed in accordance with clause 2.3.8(a) must not exceed 95% of the relevant *rotor angle*, or other *stability* limit as may be applicable, whichever is the lowest.

(c) Where the *power transfer* limit assessed in accordance with clause 2.3.8(a) is determined by the thermal rating of *equipment*, short term thermal ratings should also be determined and applied in accordance with *good electricity industry practice*.

2.3.9 Assessment of *Power System* Performance

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 clause 2.2section 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 2.7.Table 2-10. Records of all test results must be retained by the *Network Service Provider* and made available to the *Authority*, *System Management or the Independent Market Operator* or *AEMO* on request.

Table 2.~~-~~10 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.~~

~~2.4 LOAD SHEDDING FACILITIES~~

~~2.4.1 Settings of Under-*Frequency Load shedding* Schemes~~

~~(a) The settings for the under-*frequency load shedding* (UFLS) scheme are stated in Table 2.8.~~

~~(b) Switchable *capacitor banks* at *substations* must be shed in accordance with Table 2.8.~~

~~Table 2.8 Under-frequency load shedding scheme settings for the South West Interconnected Network~~

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.

~~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~~

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(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 the *transmission and distribution systems* to maintain sufficient *system strength* to ensure the stability requirements in clauses 2.2.8 and 2.2.9 and the *protection* requirements set out in section 2.9 can be met.

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 ~~AND DISTRIBUTION~~ SYSTEM PLANNING CRITERIA

2.5.1 Application

~~The~~ Section 2.5 sets out the *transmission system* *planning criteria* ~~in this clause 2.5 apply only to the *transmission and distribution systems* and not to *connection assets*.~~. The *Network Service Provider* must design ~~*connection assets* in accordance with a *User's* requirements and the relevant requirements of section 3.~~

~~**2.5.2 Transmission system**~~

~~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.

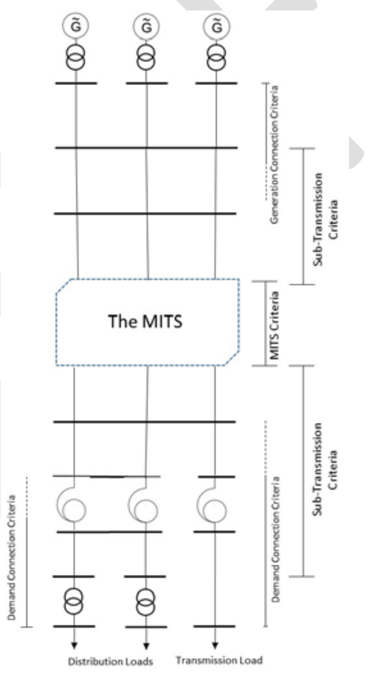


Figure 2-5 Overview of *Main Interconnected Transmission system* with *Generator* and Demand Connections

(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 the 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 the 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:

2.5.2.1 N-0 Criterion

(a) A sub-network of the *transmission system* designed to the N-0 criterion will experience the loss of the ability to transfer power into the area supplied by that sub-network on the loss of a *transmission element*. Following such an event this *power transfer capability* will not be restored until the *transmission element* has been repaired or replaced.

(b) The N-0 criterion may be applied to sub-networks with a *peak load* of less than 20 MVA and to *zone substations* with a *peak load* of less than 10 MVA. The N-0 criterion also applies toAn 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 *interconnection*line supplying the Eastern Goldfields region.

An **Note:**
In the event of an unplanned outage of theon this 220 kV *interconnection* supplyingline may result in a loss of supply to the Eastern Goldfields region the *power system* is expected to split into two islands. Arrangements. However, arrangements are in place with local generation to supply the Kalgoorlie-Boulder city and Coolgardie town *loads* during an *interconnection outage* but *Users* outside these areas will need to make their own arrangements for any back-up generation requirement.such an outage.

(c) For a sub-network designed to the N-0 planning criteria, the *Network Service Provider* must use its best endeavours to transfer *load* to other parts of the *transmission or distribution system* to the extent that this is possible and that spare *power transfer* capacity is available. If insufficient back-up *power transfer* capacity is available, *load shedding* is permissible. Where a supply loss is of long duration, the *Network Service Provider* must endeavour to ration access to any available *power transfer* capacity by rotating the *load shedding* amongst the *Consumers* affected.

(d) At *zone substations* subject to the N-0 criterion, the *Network Service Provider* may, at its discretion, install a further *supply transformer* if insufficient back-up *power transfer* capacity is available to *supply loads* by means of the *distribution system* to allow planned *transformer* maintenance to occur at off peak times without shedding *load*.

2.5.2.2 N-1 Criterion

(a) Any sub-network of the *transmission system* that is not identified within this clause 2.5.2 as being designed to another criterion must be designed to the N-1 planning criterion.

For sub-networks designed to the N-1 criterion, *supply* must be maintained and *load shedding* avoided at 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 jointly agree with *AEMO* a 'Generation Dispatch for Network Planning Guideline' describing the process used when setting the *generation dispatch* used in *planning timescales* for the background conditions outlined in Attachment 14 (BACKGROUND CONDITIONS FOR *TRANSMISSION* PLANNING) and for various other studies. The 'Generation Dispatch for Network Planning Guideline' must be reviewed and updated on an annual basis.

(k) 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 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 system by the *credible contingency*, plus

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

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

(A) any ~~*load* level and for any *generation* schedule following an~~ demand that may be automatically tripped for *frequency* control purposes on the 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* and *AEMO*.

(d) *Generation* connections shall be planned such that, starting with an *intact system*:

(1) during the *planned outage* of any single section of *busbar*, no reduction of *generation* capacity greater than 150 MW shall occur;

(2) following a *credible contingency* of any single *transmission* ~~*element*,~~*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*;

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

(4) following the *credible contingency* of 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

(5) following the *credible contingency* of 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 cycles, typical *generation* operating regimes and typical *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:

(b)(7) *loss of demand* except where: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:**
> aThe *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 2-11;

(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*;

(1) a single *zone substation* was designed to the 1% risk or NCR criteria in accordance with clause 2.5.4; or

(2) operational restrictions have been agreed between the *Network Service Provider* and a *User* as per clause 3.1(b).

(c) Following the loss of the *transmission element*, the *power system* must continue to operate in accordance with the *power system* performance standards specified in clause 2.2.

(d)(2) Notwithstanding the requirements clauses 2.5.2.2(b) and 2.5.2.2(c), where the failed *transmission element* is a *zone substation supply* transformer, *supply* may be lost for a brief switching period while *loads* are transferred to un-faulted *supply transformers* by means of *distribution system* switching. The *Network Service Provider* must maintain sufficient *power transfer* capacity to allow *supply* to all *Consumers* to be restored following switching.;

2.5.2.3 N-1-1 Criterion

(3) The N-1-1 Criterion applies to those sub-networksa 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 *transmission system* where the occurrence of a *credible contingency* during planned maintenance of anotherof 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 2-11;

(15) *unacceptable overloading* of any *transmission element* would otherwise*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 loss of *supply* to a large number of *Consumers*. Sub-networks of the disconnection of demand must ensure the limits set out in Table 2-11 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.

(a)(b) The *transmission system* that are designed to*capacity* for the connection of a *demand group* shall also be planned such that for the N-1-1 criterion include: background conditions described in clause 2.5.4.2 and the initial conditions of:

(1) all 330 kV lines, substations and power stations;

(2) all 132 kV *terminal stations* in the Perth metropolitan area, and Muja *power station* 132 kV *substation*;

(1) all 132 kVthe single *unplanned outage* or *fault outage* of a *transmission lines* that *supply* a sub-system of the *circuit* or *zone substation transformer* for the *Perth CBD*

for the *credible contingency* of:

(3)(2) a single fault outage of a *transmission system* comprising more than 5 *zone substations* with total *peak load* exceeding 400 MVA; and*circuit* or *zone substation transformer* for the *Perth CBD*

all power stations whose total rated export to thethere must be no:

(3) *loss of demand* except as specified in Table 2-11;

(4) *unacceptable overloading* of any *transmission system* exceeds 600 MW.*equipment*;

(5) The range of operating*unacceptable voltage* conditions; or

(6) *system instability*.

> **Note:**
> that For clarity, clauses 2.5.4.6(b)(3), 2.5.4.6(b)(5), 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 2-11 are allowed for whennot 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*

(b)(a) In planning a part of the *transmission system* to meet the N-1-1 criterion is set out in Table 2.9. *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 2-11.

Table 2.9 Transmission system operating conditions allowed for by the N-1-1 criterion

Maintenance *Outages* and Contingencies
transmission line maintenance and unplanned transmission line outage
transformer maintenance and unplanned transformer outage
transformer maintenance and unplanned transmission line outage
busbar maintenance and unplanned transmission line outage
busbar maintenance and unplanned *transformer outage*
circuit breaker maintenance and unplanned *transmission line outage*
circuit breaker maintenance and unplanned *transformer outage*
circuit breaker maintenance and unplanned *busbar outage*
transmission line maintenance and unplanned transformer outage

(b) Under the N-1-1 criterion, each sub-network must be capable of withstandingFollowing the coincident planned and occurrence of two *unplanned outages* or *fault outages* affecting a *demand group* excluding the *Perth CBD* area, *group demand* can be lost for the duration of the associated repair time.

Note:

of 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. These requirements must also be met.

Table 2-11 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 *sub transmission system* are described in Attachment 14.

(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* ~~listed in Table 2.9~~specified in clause 2.5.5.5 at ~~up to~~ *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 the 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 section of *busbar*;

(3) a single circuit breaker;

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

(5) a single *reactive equipment*.

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

(6) a single *transmission circuit*;

(7) a single section of *busbar*;

(8) a single *reactive equipment*; or

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

there must be no:

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

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

(12) *unacceptable voltage conditions*; or

(13) *system instability*.

Note:
. For clarity, clauses 2.5.5.5(a)(11), 2.5.5.5(a)(12), and 2.5.5.5(a)(13) 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 2-11 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.

(c)(b) In determining whether the N-1-1 criteriarequirements 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 thea subsequent unplanned*fault* *outage*.

2.5.5.6 Following the unplanned *outage* of the Other *MITS* and *sub* *transmission* *element*,*system* requirements

(a) Under the System Security Background conditions (Attachment 14), the criteria in clauses 2.5.5.2 to 2.5.5.5 must be met.

(b) Under the *power system* must continue to operateSystem Economy Background conditions (Attachment 14), 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 the performance standards specified in clause 2.2, providedclauses 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*.

(d)(e) For potential *MITS* and *sub* *transmission* system *load* remains below 80% of the expected *peak load**augmentations* identified following assessment using the System Economy Background conditions (Attachment 14), 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

2.5.2.4 ApplicationCircuit Breaker Failure

If a *circuit breaker failure* occurs and, as a result, a single phase to earth fault within a *transmission system* sub-network designed to the N-1-1 criterion is not cleared by a *main protection scheme*, the *power system* must return to a state that meets the steady state performance standards specified in clause 2.2.2 without *generation* rescheduling, provided that the *power transfer* at the time of the fault is no greater than 80% of the expected *transmission system peak load* and that, prior to the event, all *transmission system equipment* is in service.

2.5.3 Perth CBD Criterion

(a) The *Perth CBD* criterion applies to those sub-networks of the *transmission system* that transfer power to the *Perth CBD* and *zone substations* and the *transmission* lines that terminate in those *zone substations* that supply *Perth CBD.*

(b) Following any *outage* within a sub-network to which the *Perth CBD* criterion applies involving:

(1) one or two *transmission* lines;

(2) one or two supply transformers; or

(3) one transmission line and one supply transformer,

and irrespective of whether any single *transmission element outage* is planned or unplanned, there must be sufficient *power transfer* capacity in the *transmission system* to maintain *supply* to all *Consumers* within the *Perth CBD* without the need to reschedule generation.

(c) For an unplanned *outage* of a single *supply transformer*, there may be a *supply* interruption to some *Consumers* of up to 30 seconds to allow for the automatic transfer of the affected *loads* to other *supply transformers* within the same *substation* or to other *substations* using capacity that is kept available for this purpose.

(d) For unplanned *outages* of two *transmission elements* in accordance with clause 2.5.3(b), there may be a *supply* interruption to some *Consumers* of up to 2 hours to allow for the transfer of the affected *loads* to other *supply transformers* within the same *substation* or to other *substations* using capacity that is kept available for this purpose.

(e) Apart from the *supply* interruptions provided for in clauses 2.5.3(c) and 2.5.3(d), the *power system* must continue to meet the performance standards specified in clause 2.2.

2.5.4 Zone Substations

(a) The 1% Risk Criterion

The 1% Risk criterion permits the loss of supply to that portion 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 that *substation*.

(b) Normal Cyclic Rating (NCR) Criterion

(1) The NCR risk criterion permits a limited amount of unmet demand for *power transfer* capacity following the unplanned loss of a *supply transformer* within a *substation*.

(2) The maximum *power transfer* through a *substation* subject to the NCR risk criterion must be the lesser of:

(A) 75% of the total *power transfer* capacity of the *substation*, with all supply transformers in service; or

(B) the *power transfer* for which the maximum unmet demand for *power transfer* capacity following the loss of the largest *supply transformer* in the *substation* is equal to 90% of the *power transfer* capacity of the rapid response spare *supply transformer*.

2.6.1

Section 2.6 sets outNote:

Relationship between 1% Risk criterion and NCR criterion is explained below:

1. *Zone substations* require special consideration as they form the boundary between the *transmission system* and the distribution system. The 1% Risk Criterion and NCR Criterion permit higher *supply transformer* utilisation than that permitted by the N-1 criterion, but lower than that permitted by the N-0 criterion.
2. The 1% Risk and NCR criteria are based on sharing a common spare *supply transformer* among a population of *supply transformers* across a number of *zone substations* within a geographically confined area. A trade off is the risk of limited *load shedding* for as long as it takes to deploy and install a spare *supply transformer*. The acceptance of this risk determines the application of these two criteria.

2.5.4.1 Application of 1% Risk criterion

(a) The *Network Service Provider* may apply the 1% Risk criterion to major regional *zone substations* outside the Perth metropolitan area.

(b) No *zone substation* may be classified a 1% Risk *substation* unless a suitable system spare *transformer* is available to replace the failed *transformer* within a target period of 10 *days*.

(c) Following the loss of a *supply transformer* from a 1% Risk *zone substation* the *Network Service Provider* must use its best efforts to minimise *load shedding* by transferring *load* to other *zone substations* by utilising available spare capacity.

2.5.4.2 Application of the NCR Criterion

(a) The *Network Service Provider* may apply the NCR Risk criterion to *zone substations* in the Perth metropolitan area. *Zone substations* supplying *essential services* and *zone substations* where the application of the NCR Risk criterion is technically or economically unviable may be exempt from classification as NCR classified *substations* and must fully meet the N-1 planning criteria.

(b) No *zone substation* may be classified an NCR *substation* unless a rapid response spare *transformer* is available to temporarily replace the failed *supply transformer* within a target period of 12 hours.

(c) Following the loss of a *supply transformer* from an NCR classified *zone substation*, the The *Network Service Provider* must use its best efforts to minimise *load shedding* by transferring *load* to other *supply transformers* or *zone substations* by utilising available *spare capacity*design the *distribution system* in accordance with the applicable *distribution system planning criteria* described below.

(d) Following the deployment of the rapid response spare *transformer*, the *Network Service Provider* must install a suitable spare *transformer* or procure a new *transformer* to replace the failed *transformer* permanently and release the rapid response spare *transformer* to cater for future contingencies.

2.5.52.6.2 *High* Voltage Distribution System *voltage distribution system*

2.5.5.12.6.2.1 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*.

2.5.5.22.6.2.2 *Distribution* Feedersfeeders 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.

2.5.5.32.6.2.3 Urban *Distribution Feedersdistribution feeders*

(a) Existing Urban Distribution Feedersurban *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*distribution feeders* constructed after the *Rules* Commencement Date*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) theThe *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 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, but can be closed to provide *supply*, if a fault occurs on the normal *supply*.

2.5.5.42.6.2.4 Radial *Distribution Feeder Loadsdistribution feeder loads* in the Perth Metropolitan Areametropolitan area

For all *distribution feeders* within the Perth metropolitan area, the *Network Service Provider* must limit the number of residential *ConsumersUsers* 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.

2.5.5.52.6.2.5 Rural *Distribution* Feeders*distribution* feeders

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

2.5.62.6.3 *Low* Voltage Distribution System*voltage distribution system*

2.5.6.12.6.3.1 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*.

2.5.6.22.6.3.2 Pole to Pillar *Connection Points* Mandatorypillar *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.

2.5.72.6.4 Fault Limitslimits

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

2.5.82.6.5 *Maximum* Fault Currents*fault currents*

(a) 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*.

(b)(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*.

(2)(3) 6.6 kV networks 21.9 kA

(3)(4) 11 kV networks 25 kA

(4)(5) 22 kV networks 16 kA

(5)(6) 33 kV networks 13.1 kA

(c)(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 events*.

2.6 DISTRIBUTION DESIGN CRITERIA

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. The maximum reasonably foreseeable *load* must be determined by estimating the *peak load* of the area after it has been fully developed, taking into account restrictions on land use and assuming current electricity consumption patterns.

(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 to 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) *Distribution transformers* rated at 300 kVA or above must be fitted with *load monitoring equipment*. This must provide a :

(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:
mustClause 2.6.6(f)(2) may be capable of being modified in future to enableachieved through the use of the equipment that allows for remote monitoring ofon 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:
(f) *load*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 customer behaviour.

2.7 TRANSMISSION AND DISTRIBUTION SYSTEM DESIGN AND CONSTRUCTION STANDARDS

The *Network Service Provider* must ensure thatWhen designing and constructing the *transmission and distribution system* complies, 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 codes standards and regulations, including the *Access Code*, *Australian* and*Standards,* International Electricity Commission (IEC) Standards, and relevant 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 life timelifetime 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 Requirementsrequirements

(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)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 *AS* 60044 (2003).IEC Standard 61869.

2.9.2 Duplication of *Protection 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 of differing principle*.. 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* of differing principle that must discriminate with other *protection schemes*. For *primary equipment* operating at nominal *voltages* of less than 220kV220 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 of differing principle*.

(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)2.9.2(b)(1).

(b) *Distribution system*

(1) EachOther 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)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* *of differing principle* and comply with the requirements of clause 2.9.2(a)(3)2.9.2(a)(3).

2.9.3 Availability of ***Protection Systems******protection systems***

(a) AllSubject 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 every 6 months.

(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 unless instructed otherwise by *System Management*., 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 unless the part of the *distribution system* must remain in service to maintain *power system stability*., 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~~total *fault clearance times*

(a) This clause ~~2.9.4~~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.~~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 2.10~~Table 2-12 and ~~Table 2.11~~Table 2-13 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, 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 2.10.~~Table 2-12. 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 2.10.~~ Table 2-12.

(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 2.10.~~Table 2-12. 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 2.11.~~Table 2-13. The *back-up protection system* must achieve a *total fault clearance time* no greater than the "CB Fail" time in ~~Table 2.10,~~Table 2-12, 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 2.11; and~~Table 2-13; 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 2.11~~Table 2-13 (rather than the times specified in ~~Table 2.10).~~Table 2-12). 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 2-13.

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

(f) ~~In Table 2.10 and Table 2.11,~~In Table 2-12 and Table 2-13, 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 2.10 and Table 2.11,~~In Table 2-12 and Table 2-13, 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 2.10,~~In Table 2-12, 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 any other provision contained in ~~Rule 2.9.4,~~clause 2.9.4, for *weak infeed fault conditions* resulting from the connection of ~~*embedded*~~ *generating units*, the *total fault clearance time* of one of the *protection schemes* shall meet the remote end *total fault clearance time* of ~~Table 2.11.~~Table 2-13 without consideration of *circuit breaker failure*. 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. The requirements of this clause are only applicable in cases where, in the opinion of the *Network Service Provider*, the risk of undetected islanding of part of the *transmission or distribution system* and the *Generator's facility* remains significant.

> **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.

Table 2.-12 Maximum *total fault clearance times* (msec).)

		~~Existing *Equipment* No CB Fail~~ Existing equipment no CB fail	~~Existing *Equipment* CB Fail~~ Existing equipment CB fail	~~New *Equipment* No CB Fail~~ New equipment no CB fail	~~New *Equipment* 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.-13 Alternative maximum *total fault clearance times* (msec) for 132 kV and 66 kV lines.

		Existing ~~*Equipment* No~~equipment no CB ~~Fail~~fail	Existing ~~*Equipment*~~equipment CB ~~Fail~~fail	New ~~*Equipment* No~~equipment no CB ~~Fail~~fail	New ~~*Equipment*~~equipment CB ~~Fail~~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~~*fault clearance times*

(a) Notwithstanding the requirements of clause ~~2.9.4~~2.9.4, where necessary to ensure that the *power system* complies with the performance standards specified in clause ~~2.2~~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 2.10.Table 2-12. 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(a).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 Sensitivitysensitivity*

(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*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 Requirementscircuit 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* Flaggingflagging and Indicationindication

(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 ensure that prompt action is taken to remedy such failures.

3. *TECHNICAL REQUIREMENTS OF USER FACILITIES*

3.1 INTRODUCTION

(a) This sectionChapter 33 sets out details of the technical requirements whichthat *Users* must satisfy as a condition of *connection* of any equipment to the *transmission and distribution systems* (including *embeddedloads, generating unitssystems 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 section 3This 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 section 3Chapter 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 objectivesobjective of this sectionChapter 33 areis to facilitate maintenance of the *power system* performance standards specified in section 2.22.2, 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'sUser's* equipment.

Note:

Note:

The scope of these *Rules* does not include the technical requirements for the provision of *ancillary* services either in accordance with the relevant provisions of the *MarketWEM Rules* or under a commercial arrangement with the *Network Services Provider*. *Users* who provide these *ancillary*those services may be required to comply with technical requirements over and above those specified in this section 3.Chapter 3. These additional requirements will be specified in the relevant *ancillary* 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 Generators* 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)	All	sections 3.1, 3.2, 3.4 and 3.5
electricity storage	discharging *active power*	> 5 MVA	sections 3.1, 3.2, 3.3 and 3.5
electricity storage	discharging *active power*	≤ 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
generating system	-	≤ 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)	All	sections 3.1, 3.2, 3.4 and 3.5
generating system	-	> 5 MVA, *HV connected*	sections 3.1, 3.2, 3.3, and 3.5
electricity storage	discharging *active power*	> 5 MVA, *HV connected*	sections 3.1, 3.2, 3.3, and 3.5
generating system	-	≤ 5 MVA, *HV connected*	sections 3.1, 3.2, 3.5, and 3.6
electricity storage	discharging *active power*	≤ 5 MVA, *HV connected*	sections 3.1, 3.2, 3.5, and 3.6
generating system	-	*LV connected, non-standard connection service*	sections 3.1, 3.2, 3.5 and 3.7
electricity storage	discharging *active power*	*LV connected, non-standard connection service*	sections 3.1, 3.2, 3.5 and 3.7
generating system	-	*LV connected, standard connection service*	sections 3.1, 3.2, 3.5 and 3.8
electricity storage	discharging *active power*	*LV connected, standard connection service*	sections 3.1, 3.2, 3.5 and 3.8

(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*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:

Note:
The overvoltage envelope specified in Figure 2.1Figure 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 2.4~~Table 2-7 and ~~Table 2.5~~Table 2-8 to be exceeded at the ~~point of~~ *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 2-9.

(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 ~~*Australian Standard*~~ AS 2344 (~~1997~~2016).

(f) Fault Levels

(1) A *User connected* to the *transmission system* ~~may~~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(a).~~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 ~~2.5.7(b)~~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 ~~fault level with a~~ lower fault rating than the *maximum fault current* specified in clause ~~2.5.8(b)(1)~~2.6.5(a)(1) in accordance with the applicable requirements of the *WA Electrical Requirements*.

~~**Note:**~~

Note:
Where a ~~*User's*~~*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~~switch

(a) Except as provided in clause ~~3.3.3.10~~3.3.15, a *User* must be able to de-energise its own equipment without reliance on the *Network Service Provider*.

~~3.2.3 User's Power Quality Monitoring Equipment~~

(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). The main switch(s) must be circuit breaker(s) and where:

(1) a single main switch is installed, it shall be rated to the lesser value of the network connection service capacity or the *User's* requested and agreed calculated maximum demand for the *User's* electrical installation, or

(2) multiple main switches are installed, the sum of the *current ratings* of the individual main switches shall not exceed the lesser value of network connection service capacity or service protection device (SPD) rating.

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*~~*User's* *facilities* or at the *connection point*. ~~In such an event the~~

~~(a)~~(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 ~~shall~~ provide access for reading, operating and maintaining this equipment.

~~(b)~~(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 Power System Simulation Studies

3.2.4 Modelling data for *power system* simulation studies

(a) A *User* must provide to the *Network Service Provider* such of the followingmodelling information relating to any of the *User's*for their *facilities* *connected* or intended to be *connected* to the *transmission system* as is required to enable the undertaking of *power system* simulation studies:

(1)(a) a set of functional block diagrams, including all transfer functions between feedback signalsspecified in the 'Generator and *generating unit* output;Load Model Guidelines' produced by the *Network Service Provider*.

(2) the parameters of each functional block, including all settings, gains, time *constraints*, delays, dead bands and limits; and

(3) the characteristics of non-linear elements.

(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 Mattersmatters to be Coordinatedcoordinated

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; and

(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 ensure that the design of their *facilities* comply with the *WA Service and Installation Requirements*.

3.3 REQUIREMENTS FOR CONNECTION OF LARGE GENERATING ~~UNITS~~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.

~~3.3.1~~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 ~~units~~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 ~~any and all~~ *directions* given by ~~*System Management*~~*AEMO* and the *Network Service Provider* under these *Rules* or under any *written law*.

~~(c) For generating *equipment* the combined rating of which is less than 10 MW and which is *connected* to the *distribution* system, the *connection* requirements of clause 3.6 or clause 3.7 apply. This clause 3.3 applies to *generating equipment* the combined rating of which is 10MW or greater.~~

> ~~**Note:**~~
> ~~The 10 MW threshold is chosen to coincide with the cut-off size for compulsory participation in the Electricity Market. Electricity Market participation is compulsory for *generation equipment* rated 10 MW and above.~~

~~(d)~~(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) ~~reduced rotor angle~~transient stability~~;~~ or oscillatory stability;

(2) ~~reduced~~*unacceptable frequency* ~~stability~~*conditions*; or

(3) ~~reduced~~*unacceptable voltage* ~~stability~~*conditions*,

relative to the level ~~that would apply if~~necessary to *supply* the ~~*generating unit* were not~~*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 ~~the *generator*~~those *generating units*, the *power transfer capability* of the *power system* will be reduced such that it would impede the ability to *supply load*.

(e)(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.

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

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

(g) A *Generator* responsible for a *large* *generating* *unitsystem connected to the transmission system* must *disconnect* from the 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* if the *distribution feeder* to which it is *connected* is separated from the remainder of the *power system*. must comply at all times with *protection* requirements specified in clause 3.5.1 and 3.5.3.

3.3.23.3.3 Provision of Informationinformation

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

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

~~3.3.3 Detailed Technical Requirements Requiring Ongoing Verification~~

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 *registered 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 *registered 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* consider 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 technical requirements of this clause 3.3.3*generator performance standards* developed through the process defined in this clause 3.3.4.2 by the methods described in clause 4.1.3.

3.3.3.1 Reactive Power Capability

3.3.5 Each *Potential relevant generator modifications* to existing *generating* *unit,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:**
> *power station* inThe purpose of this clause is to clarify that if the *large generating system* has agreed generator *performance standard* 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,

(5) but does not include the replacement of equipment where the capacity of the *generating system* to meet its *generator performance standards* or technical requirements remains unchanged as a result of the replacement of equipment.

(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) As the *ideal generator performance standard* is the same as the *minimum generator performance standard* for *active power* capability, there are no additional *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 *active power* capability.

(c) *Minimum generator performance standard*

(1) In relation to the application of this technical requirement, the requirements apply at the *connection point* unless otherwise specified.

(2) The *generator performance standard* for *active power* capability must include *temperature dependency data* up to and including the maximum ambient temperature specified by the *Network Service Provider*:

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

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

(3) The maximum ambient temperature specified by the *Network Service Provider* will be based on an assessment of where the *generating system* is physically located~~,~~.

(4) Subject to clause 3.3.7.2(c)(5), the *generating system* must be capable of ~~continuously~~ achieving *rated maximum active power* output level for all operating conditions, unless otherwise directed by *AEMO* or the *Network Service Provider*, and capable of maintaining its *rated maximum active power* output level, subject to energy source availability, at temperatures up to and including the maximum ambient temperature as specified by the *Network Service Provider*.

(5) Clause 3.3.7.2(c)(4) 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.

(d) *Negotiation criteria*

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

3.3.7.3 *Reactive power* capability

(a) *Common requirements*

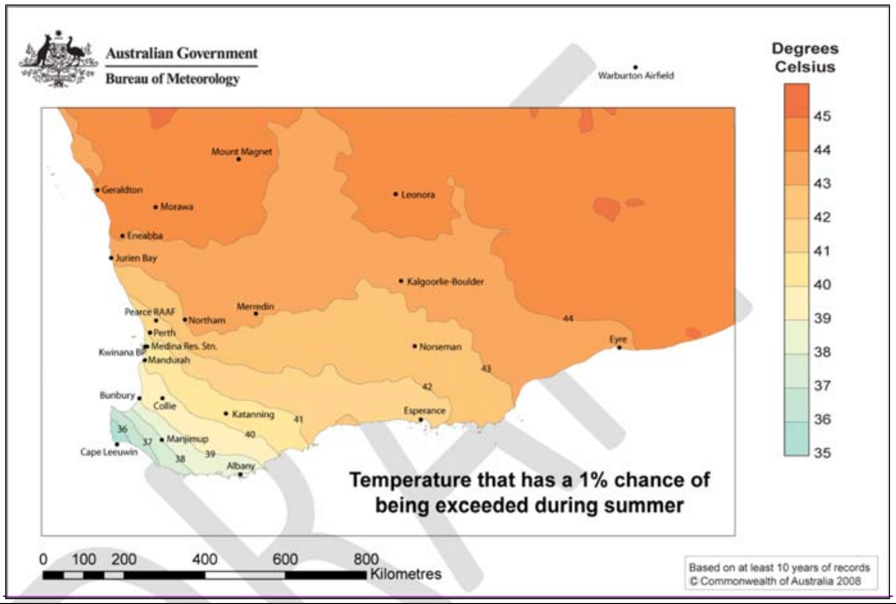
(1) In relation to the application of this technical requirement, the requirements apply at the *connection point* unless otherwise specified.

(2) The *generator performance standard* must include a *generator capability chart*, including data for the maximum ambient temperature specified by the *Network Service Provider*.

~~(a)~~(3) There must be no *control system* limitation, *protection* system or other limiting device in operation that would prevent the *generating system* from providing the ~~full~~ *reactive power* output ~~required under this clause 3.3.3.1~~

within the ~~full range of steady state *voltages* at the *connection point* permitted under clause 2.2.2.~~area defined in the *generator capability chart*.

~~This requirement must be met for all operating conditions, including ambient temperature. Unless operating restrictions have been agreed in accordance with clause 3.1(b), the *Network Service Provider* may assume the site specific maximum ambient temperature shown in the figure below when assessing compliance with the requirements of this clause.~~



~~(b) Each *generating unit* must include a controller that is capable of varying the *reactive power* at the *connection point* between the maximum import level and maximum export level required by this clause 3.3.3.1. This control must be continuous to the extent that it must not depend on mechanically switched devices other than an on-*load* tap changer forming part of the *generating unit transformer*.~~

~~**Note:**~~

~~The controller must also meet the relevant performance requirements of clause 3.3.4.5.~~

(4) ~~(1) Each *synchronous generating unit*, while operating at any level of *active power* output between its registered maximum and minimum *active power* output level,~~The maximum ambient temperature specified by the *Network Service Provider* will be based on an assessment of where the *generating units* are physically located.

(5) 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*

(c) For all operating conditions, including at temperatures up to and including the maximum ambient temperature specified by the *Network Service Provider*, each *generating unit* within the *generating system* must be capable of:

(A) supplying at its *generator machine's* terminals an amount ofor absorbing *reactive power* continuously of at least the amount equal to the product of the *rated active power* output of the *generating unit* at nominal *voltage* and 0.750; and

(B) absorbing at its *generator machine's* terminals an amount of *reactive power* of at least the amount equal to the product of the ratedmaximum *active power* output of the *generating unit* at nominal *voltage* and 0.484.

Refer to Figure 3.1 for details.

Note: This clause requires a *generator machine*, when producing its registered maximum *active power* output, to be capable of operating at any *power factor* between 0.8 lagging and 0.9 leading.

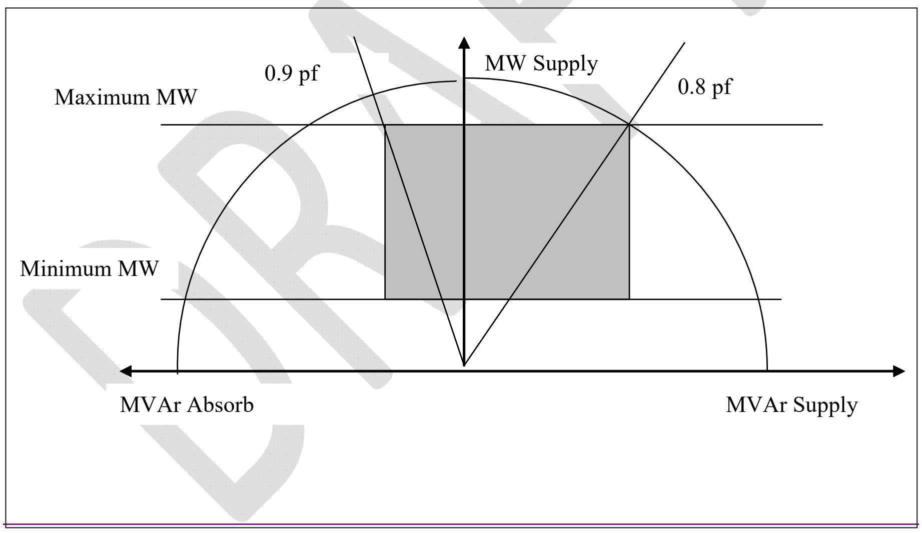


Figure 3.1 *Synchronous generating unit*. Minimum *reactive power capability* requirements at *generator machine* terminals shown shaded.

(2)(1) Each *induction generating unit*, while operating at any level of *active power* output between its registered maximum *active power* output level and its minimum *active power* output level, must be capable of supplying or absorbing an amount of *reactive power* at the *connection point* of at least the amount equal to the product of the rated *active power* output of the *generating unit* at nominal *voltage* and 0.329. Refer to Figure 3.2 for details.

as agreed by the *Network Service Provider* as part of the *generator performance standard*.

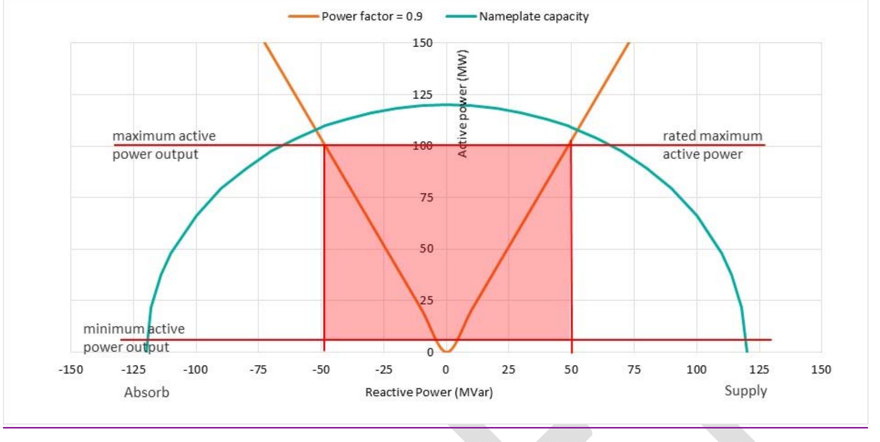


Figure 3-1 Example *reactive power capability* required to meet *ideal generator performance standard*

(2) The required levels of *reactive power capability* must be able to be delivered continuously for *voltages* at the *connection point* within the allowable *steady state voltage* ranges as specified in the *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 ambient temperature specified by the *Network Service Provider*, 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 and minimum *active power* output level as agreed by the *Network Service Provider* as part of the *generator performance standard*.

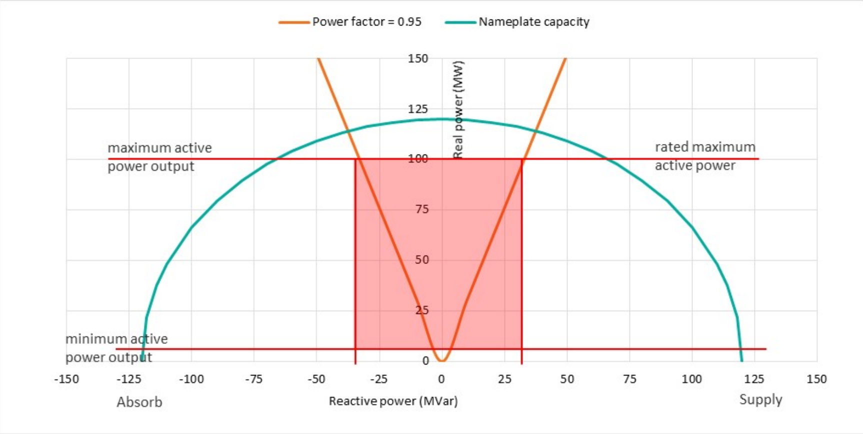


Figure 3-2 Example *reactive power capability* required to meet the *minimum generator performance standard*

(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.

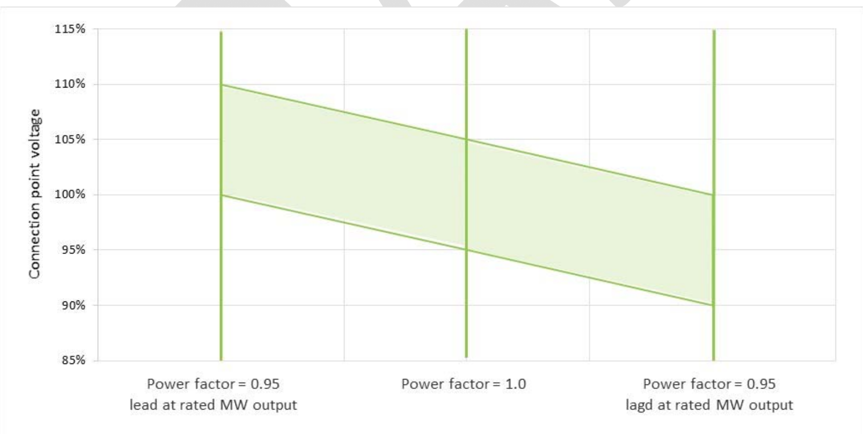


Figure 3-3 Relaxation of *reactive power* requirement with *connection point voltage*

(3) *Non-scheduled 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) There are no *common requirements* for 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 3-3 .

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* at the *connection point* or another agreed location in the *power system* (including within the *generating system*) to within 0.5% of the 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 *voltages* 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*) at the *connection point* or another location on the *power system*, as specified 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) at the *connection point* or another location in the *power system* (including within the *generating system*), as specified by the *Network Service Provider*, to within:

- for a *generating system* operating in *reactive power* mode, 2% of the *nameplate rating* (in MVA) of the *generating system* (expressed in MVAr); or
- for a *generating system* operating in *power factor* mode, a *power factor* equivalent to 2% of the *nameplate rating* (in MVA) of the *generating system* (expressed in MVAr); and

(ii) allow the *reactive power* or *power factor* 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* with *rated maximum active power* output;

(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*;

(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 for both proportional and integral control actions.

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

> **Note:**
> As specified in IEEE Standard 115-1983 - Test Procedures for Synchronous Machines, 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.

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

Performance item	**Units**	**Static excitation**	**AC exciter or rotating rectifier**
generating unit* field *voltage rise time: Time for field *voltage* to rise from rated field *voltage*(1) to excitation ceiling *voltage* following the application of a short duration impulse to the *voltage* reference.(2)	Second	0.05 maximum	0.5 maximum
Settling Time with the *generating unit* unsynchronised following a disturbance equivalent to a 5% *step change* in the sensed *generating unit* terminal *voltage*.	Second	1.5 maximum	2.5 maximum
Settling Time with the *generating unit* synchronised following a disturbance equivalent to a 5% *step change* in the sensed *generating unit* terminal *voltage*. It must be met at all operating points within the *generating unit* capability.	Second	2.5 maximum	5 maximum
Settling Time following any disturbance which causes an excitation limiter to operate.	Second	5 maximum	5 maximum

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**	***Static excitation***	**AC exciter or rotating rectifier**
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* at the *connection point* or another location in the *power system* (including within the *generating system*), as specified by the *Network Service Provider*, to within 2% of the 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* setpoint to be *controllable* in the range of at least 98% to 102% of the target *voltage* (as determined by the *Network Service Provider*) at the *connection point* or an alternative location, 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) at the *connection point* or another location in the *power system* (including within the *generating system*), as specified by the *Network Service Provider*, to within:

- for a *generating system* operating in *reactive power* mode, 5% of the *nameplate rating* (in MVA) of the *generating system* (expressed in MVAr); or
- for a *generating system* operating in *power factor* mode, a *power factor* equivalent to 5% of the *nameplate rating* (in MVA) of the *generating system* (expressed in MVAr);

(ii) allow the *reactive power* or *power factor* 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

(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* 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.

(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*.

(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*, 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.

(b) Ideal *generator performance standard*

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

(A) maintaining and changing its *active power* output in accordance with *dispatch* instructions issued by *AEMO* or the *Network Service Provider*;

(B) ramping its *active power* output linearly from one level of *dispatch* to another; and

(C) changing *active power generation* in response to a *dispatch* instruction at a rate not less than 5% of the *generating unit's* or *generating system's* rated *active power* per minute when in a thermally stable state.

(2) Subject to energy source availability, a *non-scheduled generating system* must not *change* its *active power generation* at a rate greater than 10 MW per minute or 15% of the *generating system's* aggregate *nameplate rating* per minute, whichever is the lower or as agreed with the *Network Service Provider* and *AEMO*.

(c) Minimum *generator performance standard*

(1) A *scheduled generating system* must have an *active power control system* capable of maintaining and changing its *active power* output in accordance with its *dispatch* instructions.

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

(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 otherwise by *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 50.0Hz.

(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 *rated maximum active power* for each 0.1 Hz reduction in *power system frequency* from the lower level of *frequency dead band*; 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 *rated maximum active power* 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 its *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* and *AEMO* 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*;

(b) Ideal *generator performance standard*

(1) The ideal *generator performance standard* requires that:

(A) 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:

(i) the required *frequency* response in clause 3.3.7.6(a)(10)(A) can be complied with for any initial output up to *rated maximum active power*;

(ii) 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 of at least 90% of the required *frequency* response specified in clause 3.3.7.6(a)(10) within 6 seconds; and

(iii) 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 of at least 90% of the required frequency response specified in clause 3.3.7.6(a)(10) within 2 seconds;

(iv) 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)(A)(ii)and clause 3.3.7.6(b)(1)(A)(iii) 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

(v) 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)(A)(iv) 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 *AEMO*, 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 its *rated maximum active power* output in response to a fall in the *power system frequency* 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 requirement

(a) *Common requirements*

(1) In relation to the application of this technical requirement, the requirements apply at the *connection point* unless otherwise specified.

(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.

(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.

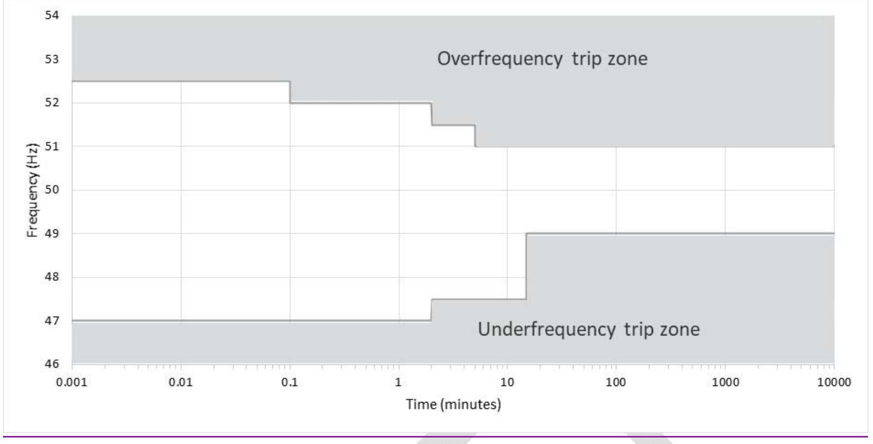


Figure 3-4 *Frequency* variations that a *generating system* must ride through to meet the *ideal generator performance standard*

(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.

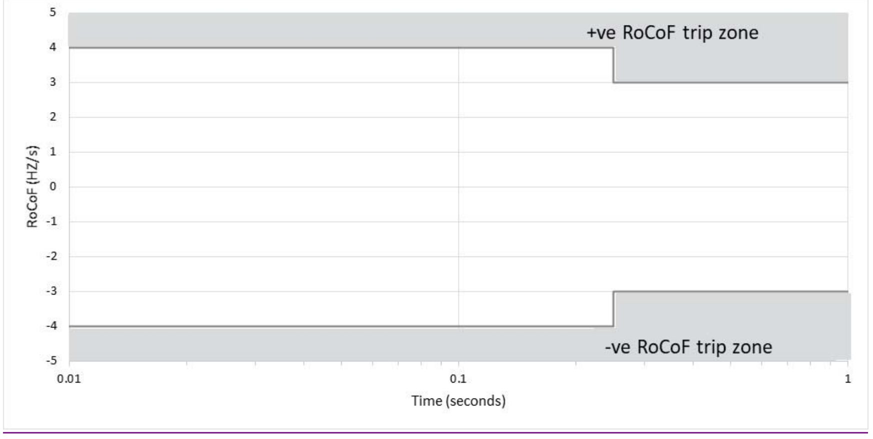


Figure 3-5 *RoCoF* that a *generating system* must ride through to meet the *ideal generator performance standard*

(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.

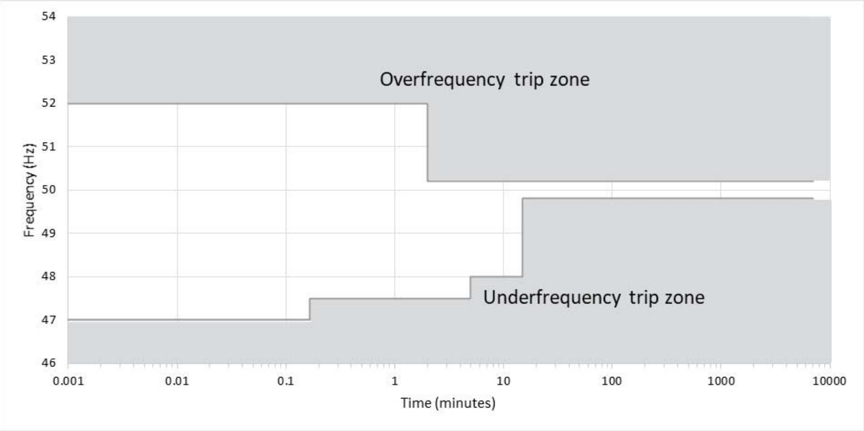


Figure 3-6 *Frequency* variations that a *generating system* must ride through to meet the *minimum generator performance standard*

(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.

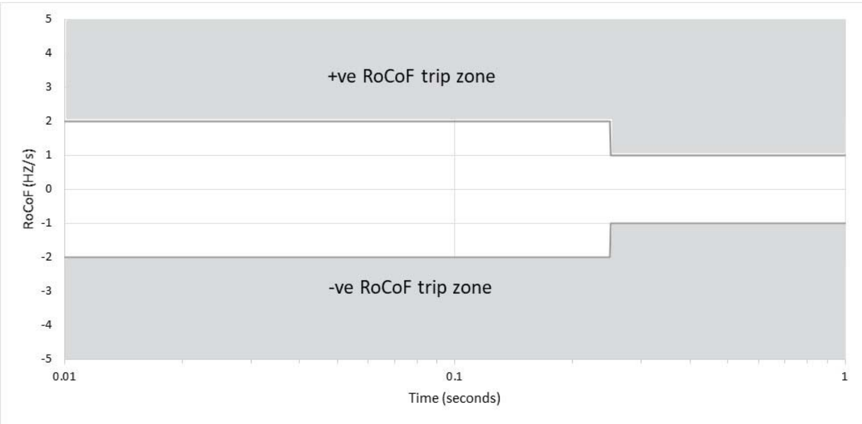


Figure 3-7 *RoCoF* that a *generating system* must ride through to meet the *minimum generator performance standard*

(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 requirement

(a) *Common requirements*

(1) In relation to the application of this technical requirement, the requirements apply at the *connection point* unless otherwise specified.

(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*.

(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*.

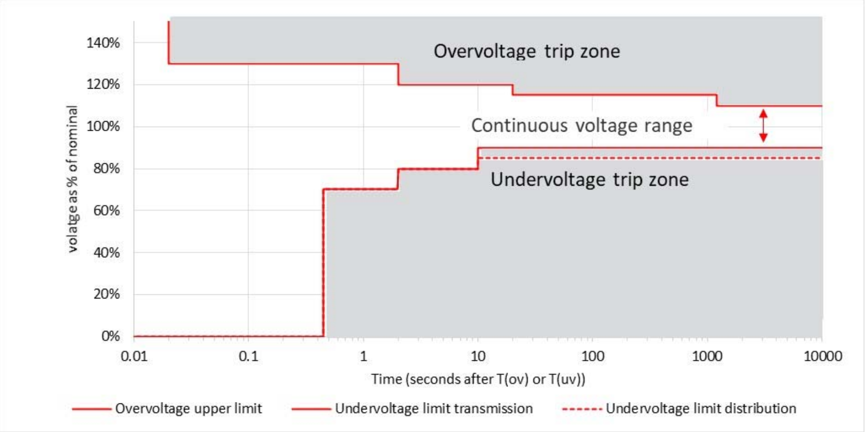


Figure 3-8 *Voltage* variations that a *generating system* must ride through to meet the *ideal generator performance standard*

(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*.

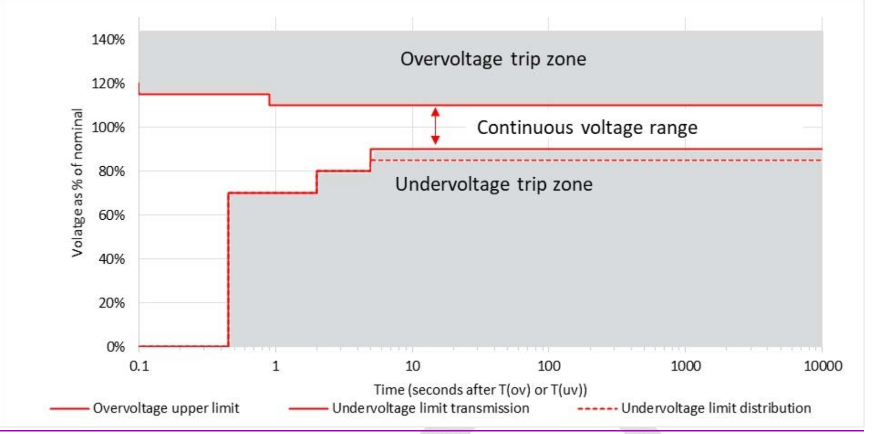


Figure 3-9 *Voltage* variations that a *generating system* must ride through to meet the *minimum generator performance standard*

(d) *Negotiation criteria*

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

3.3.7.9 Multiple disturbance ride through requirement

Note:
~~This clause requires an *induction generating unit*, when producing its registered maximum *active power* output, to be capable of operating at any *power factor* between 0.95 lagging and 0.95 leading.~~

~~(3) Where necessary to meet the performance standards specified in clause 2.2, the *Network Service Provider* may require an *induction generating unit* to be capable of supplying or absorbing a greater amount of *reactive power* output than specified in clause 3.3.3.1(c)(2). The need for such a requirement will be determined by *power system* simulation studies and any such a requirement must be included in the *connection agreement*.~~

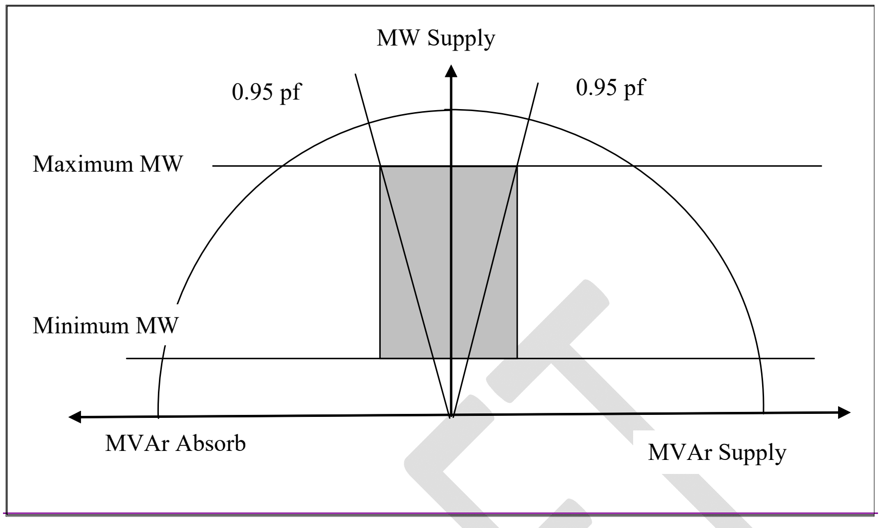


Figure 3.2 *Induction generating unit*. Minimum reactive capability requirements at *connection point* shown shaded

(4) Each *inverter coupled generating unit* or *converter coupled generating unit*, while operating at any level of *active power* output between its registered maximum and minimum output level, must be capable of *supplying reactive power* such that at the inverter or converter *connection point* the lagging *power factor* is less than or equal to 0.95 and must be capable of absorbing *reactive power* at a leading *power factor* less than or equal to 0.95. Refer to Figure 3.3 for details.

(5) Where necessary to meet the requirements of these *Rules*, the *Network Service Provider* may require an inverter *generating unit* to be capable of supplying a *reactive power* output coincident with rated *active power* output over a larger *power factor* range. The need for such a requirement will be determined by *power system* simulation studies and any such a requirement must be included in the *connection agreement*.

(d) For *generating units* not described by clause 3.3.3.1(c), the *power factor* requirements must be as advised by the *Network Service Provider* and included in the *connection agreement*. In determining the appropriate *power factor* requirement, the *Network Service Provider* must consider the intrinsic capabilities of such a new technology and the potential for its penetration.

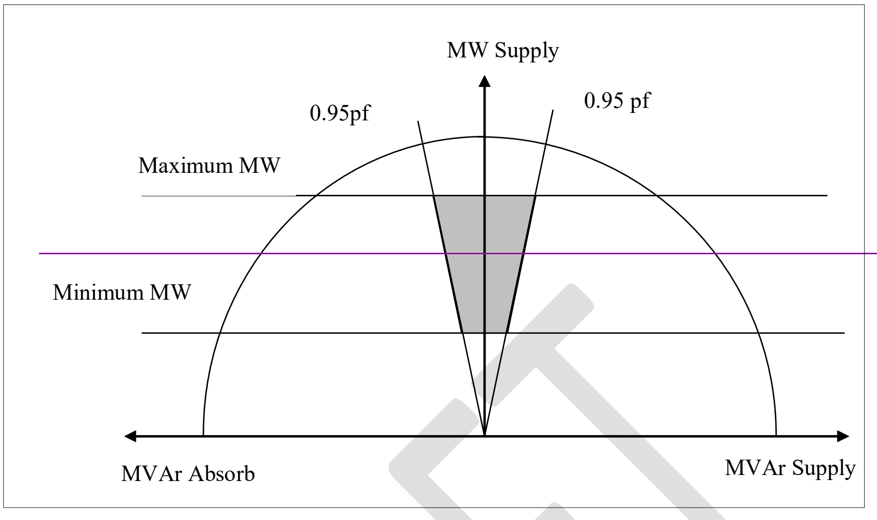


Figure 3.3 *Inverter coupled generating unit* or *converter coupled generating unit*. Minimum reactive capability requirements at *connection point* shown shaded.

(e) If the *power factor* capabilities specified in clause 3.3.3.1(c) cannot be provided by the *generator machine*, the *Generator* must provide the required capacity by including an additional source of *reactive power* within the *facility*. The *control system* for the additional source of *reactive power* must be coordinated with that of the main *generator* and, together, they must meet the performance requirements of clause 3.3.4.5.

Note:

Clause 3.3.3.1(e) is intended to facilitate flexibility in design by assisting proponents to connect *generating units* that, of themselves, are not capable of meeting the *reactive power* generation requirements specified in clause 3.3.3.1 through providing for the shortfall to be made up through some other means such as *static VAr compensators, static synchronous compensators*, inverters, thyristor switched *capacitor banks* and thyristor switched *reactors*.

(f) If the *voltage* at the *connection point* falls below the steady state level permitted by clause 2.2.2, the output *current* of the *facility* must not be less than the output *current* of the *facility* if it was providing the maximum *reactive power* required by this clause 3.3.3.1 when generating its maximum rated *active power* with the *connection point* at *nominal voltage*.

(g) The *Network Service Provider* may agree not to require full compliance with the requirements of this clause 3.3.3.1 in return for a capital contribution towards the provision of new sources of *reactive power* within the *transmission* or *distribution network*. The basis for determining the required capital contribution must be the additional capital cost that the proponent would reasonably be expected to incur if full compliance with the requirements of this clause was not waived.

(h) Each *generating unit's connection point* must be designed to permit the *dispatch* of the full *active power* and *reactive power capability* of the facility.

3.3.3.2 *Generating Unit* Performance Standard

A *synchronous generating unit* or an *induction generating unit* must be designed to *generate* a constant *voltage* level with balanced phase *voltages* and harmonic *voltage* distortion equal to or less than permitted in accordance with either *Australian Standard AS* 1359 (1997) "General Requirements for Rotating Electrical Machines" or a recognised equivalent international standard as agreed between the *Network Service Provider* and the *User* if the *generating unit* was not *connected* to the *transmission or distribution system*.

3.3.3.3 *Generating Unit* Response to Disturbances in the *Power System*

(a) Overview

The following are design requirements for *generating units* and their auxiliary systems for continuous uninterrupted operation while being subjected to off-nominal *frequency* and *voltage* excursions. Continuous uninterrupted operation is defined in clause 3.3.3.3(h).

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)(3) and clause 3.3.7.9(a)(4).
generating system comprised solely of *asynchronous generating units*.	Clause 3.3.7.9(a)(3) and clause 3.3.7.9(a)(5).
generating system comprised of *synchronous generating units* and *asynchronous generating units*.	Clause 3.3.7.9(a)(3)and: (a) for that part of the *generating system* comprised of *synchronous generating units*, clause 3.3.7.9(a)(4)(A); (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.

Note:

Some of these requirements may be relaxed when it is considered that failure to comply would not have a material impact on safety or *power system* performance. A *Generator* seeking a relaxation of the requirements must apply for an exemption from the *Rules*.

(b) Immunity to *Frequency* Excursions:

A *generating unit* and a *power station* in which the *generating unit* is located must be capable of continuous uninterrupted operation within the *power system frequency* envelope specified in Figure 3.4. Operation for a period of at least 10 seconds is required each time the *frequency* is below 47.5 Hz. Operation for a period of at least 6 seconds is required each time the *frequency* is above 52 Hz. Below 47 Hz and above 52.5 Hz, instantaneous disconnection of *generating units* is permitted.

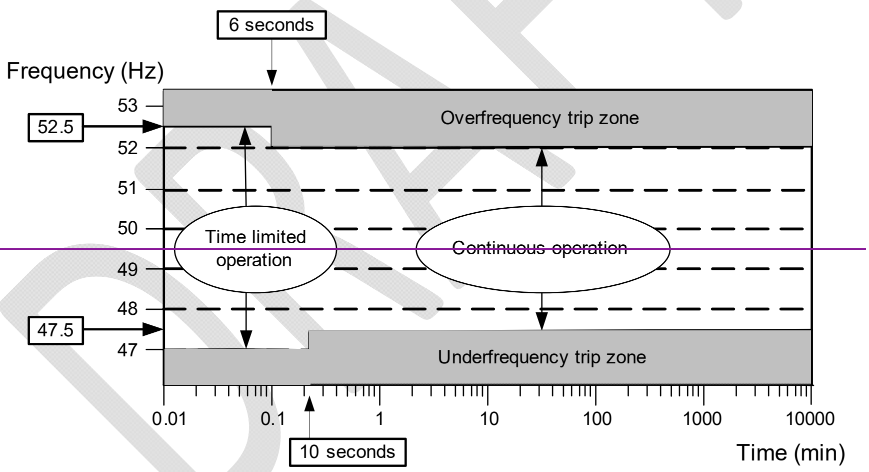


Figure 3.4 Off nominal *frequency* operation capability requirement for *generating units*

Note:

1. The requirements of Figure 3.4 provide a safety margin relative to the *frequency operating standards* of Table 2.1, within which a *Generator* may apply for an exemption from compliance from these *Rules*.
2. These requirements must be met for all operating conditions, including ambient temperature. Unless operating restrictions have been agreed in accordance with clause 3.1(b) the *Network Service Provider* may assume the site specific maximum ambient temperature indicated in clause 3.3.3.1(a) when assessing compliance with the requirements of this clause.

(c) Immunity to *Voltage* Excursions:

(1) A *generating unit* and the *power station* in which the *generating unit* is located must be capable of continuous uninterrupted operation for *transmission or distribution system faults* which cause the *voltage* at the *connection point* to drop below the nominal *voltage* for a period equal to the *circuit breaker failure* fault clearing time to clear the fault plus a safety margin of 30 msec, followed by a period of 10 seconds where the *voltage* may vary in the range 80% to 110% of the nominal *voltage,* and a subsequent return of the *voltage* within the range 90 to 110% of the nominal *voltage.*

(2) Notwithstanding the requirements of clause 3.3.3.3(c)(1) no *generating unit* shall be required to be capable of continuous uninterrupted operation where the *voltage* at the *connection point* falls below the envelope shown in Figure 3.5.

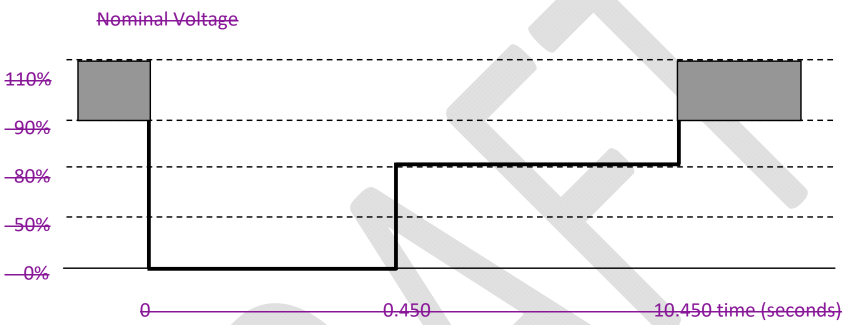


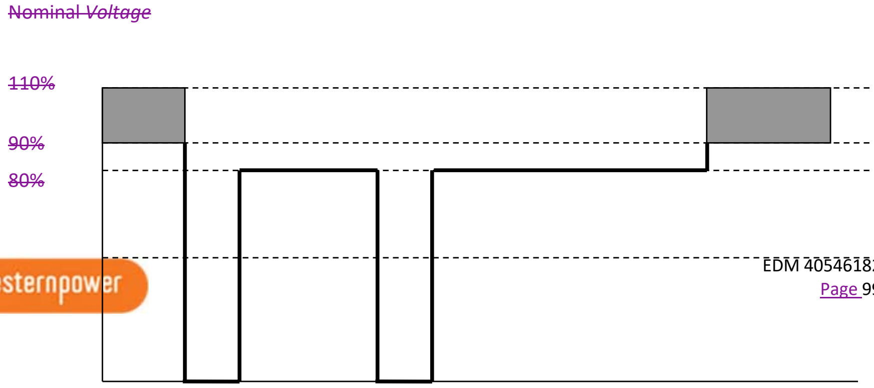
Figure 3.5 Off nominal *voltage* operation capability requirement for *generating units.*

(d) Immunity to Rate-of-Change-of-*Frequency*:

A *generating unit* and the *power station* in which the *generating unit* is located must be capable of continuous uninterrupted operation for any rate-of-change-of-*frequency* of up to 4 Hz per second.

(e) Immunity to High Speed Auto Reclosing:

A *generating unit* and the *power station* in which the *generating unit* is located must be capable of continuous uninterrupted operation for *voltage* transients caused by high speed auto-reclosing of *transmission* lines irrespective of whether or not a fault is cleared during a reclosing sequence. See Figure 3.6 for details of the *low voltage* ride through requirement during auto-reclose operation.



50%

0%

0 0.160 1.660 1.820 11.820 time (seconds)

Figure 3.6 Off nominal *voltage* operation capability requirement for *generating units* during auto-reclose operation

(f)(4) Post-Fault Reactive Power of a Power Station with Non-Synchronous Generating Units: *generating systems*

After fault clearing, the *power station* in which a *non-synchronous generating unit* is located must not absorb *reactive power* from the *transmission system* or the *distribution system*. Any pre-fault absorption of *reactive power* has to be terminated within 200 ms after clearing of the fault. The absorption is permitted to recommence, if required by the applicable *voltage* control strategy, after the post-fault *voltages* stabilize for at least 60 seconds at an above nominal value.

Note:

(A) For a *generating system* comprised solely of *synchronous generating units*, the reactive current contribution as measured at the *connection point* or another location in the *power system* (including within the *generating system*), as specified by the *Network Service Provider*, 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*

For a *generating system* comprised of *asynchronous generating units*:

(i) the reactive current contribution as measured at the *connection point* 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 *voltages*. 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.

(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 0 and clause 3.3.7.9(b)(3).
generating system comprised solely of *asynchronous generating units*.	Clause 0 and clause 3.3.7.9(b)(4).
generating system comprised of *synchronous generating units* and *asynchronous generating units*.	Clause 0 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).

All ~~This requirement is intended for undervoltage situations where a *generator* is potentially exacerbating the problem.~~

~~(g) Post Fault *Voltage* Control of a *Connection Point*:~~

(2) ~~Each *generating unit* must be fitted with an *active power* output controller, such as a governor, and a *voltage* regulator so that, following the occurrence of any *credible contingency event* and~~ *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 after *disconnection* of the faulted element, the *generating unit* must be capable of delivering to the *transmission or distribution system active power* andor 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 voltages* 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* for that *generating unit*.; and

(h) Continuous Uninterrupted Operation:

For the purposes of this clause 3.3.3.3, a *generating unit* is considered to remain in continuous uninterrupted operation if:

(1) the generating unit is not disconnected from the *transmission or distribution system* due to *protection system* operation;

(2)(iii) the *active power* output returns to the *generating unit's* pre-fault electric power output within 200100 milliseconds after the *voltage* has returned to between 80% and 110% of nominal *voltage*. In making this assessment allowances may be made for:clearance of the fault, *active power* of at least 95% of the level existing just prior to the fault.

(A) any variation in *active power* output for *non-synchronous generating units* due to variation in the primary source of *energy*; and

(4) any variation in *active* 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* output of *synchronous**system voltages* during the fault:

(B)• 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* due to any(in the absence of a disturbance) for each 1% reduction in 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* *frequency* in accordance with the registered capability of the *generating unit*.with no step-up or connection *transformer* and *voltage* at the *connection point* is 5% or lower of nominal *voltage*; and

• theinductive reactive *power control mode*current in whichaddition to its pre-disturbance level of at least 6% of the *maximum continuous current* of the *generating* *unit was**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 and energy source availability, a *generating system* must make available at all times:

(i) sufficient current to 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

(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 *equipment 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 occurring does not change, unless it is required byis 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 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 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 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 voltages* 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 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 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*.

~~(3)~~(B) The under-*voltage* and over-*voltage* range referred to in clause ~~3.3.3.3(f).~~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%).

~~**3.3.3.4 Sudden Reduction in *Active Power* Requirement**~~

(C) ~~A~~Where the *Network Service Provider* require the *generating* ~~*unit*~~*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* require 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) There are no *common requirements* for this technical requirement.

(b) Ideal *generator performance standard*

(1) A *generating system* and each of its operating *generating units* must be capable of *continuous uninterrupted operation* as defined in clause 3.3.3.3(h) 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 *generator machine's nameplate rating generating system*'s *rated maximum active power* and the required *active power generation* remains above the *generating unit's registeredsystem's rated minimum active power generation* capability.output level.

3.3.3.5 Ramping Rates

(c) Minimum *generator performance standard*

(a) A *scheduled generating unit*, in a thermally stable state,*system* must be capable of increasing or decreasing*continuous uninterrupted operation* during and following a sudden reduction in required *active power generation* in response to a manually or remotely initiated order to changeimposed from the level of generated *active power* at a rate not*system*, provided that the reduction is less than 5% of the *generator machine's nameplate rating* per minute.

(b) A *power station* that is not subject to dispatch by *System Management* must not increase or decrease its *generating system*'s *rated maximum active power* and the required *active power generation* at a rate greater than 10MW per minute or 15% of the *power station's* aggregate *nameplate rating* per minute, whichever is the greater, except when more rapid changes are necessary due to remains above the strength of the *energy* source moving outside the *power station's* design range.

Note:

(1) This requirement would normally be incorporated into the design of the *generating system's rated minimum active power* output controllerlevel.

(d) *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 the emission limits specified in AS 1359.101 and IEC 60034-1 or 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 the emission limits specified in AS 1359.101 and IEC 60034-1 or 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 *large 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 *power system 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*.

(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 *Generator* must provide and install *remote control equipment* to enable the *Network Service Provider* or *AEMO* to *disconnect* a *generating unit* from the *power system* to manage *power system security*.

(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) 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 provide for the signals specified in the 'Generating System Control and Monitoring Guideline' and such other information required by the *Network Service Provider*.

(d) 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 primary speech communication channel must be maintained in good working order.

3.3.11 *Generation* system model

(a) All modelling data described in the 'Generator and Load Model Guidelines' (developed by the *Network Service Provider* in accordance with clause 2.3.5.1(a)) 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.

3.3.3.63.3.12 Safe Shutdownshutdown without External Electricity *Supply*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*.

3.3.3.73.3.13 Restart Following Restorationfollowing restoration of External Electricity *Supply*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:
> - delaysDelays not inherent in the design of the relevant start-up *facilities* and which could reasonably have been eliminated by the relevant *Generator*; and
> - theThe 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*.

3.3.3.83.3.14 Protection of *Generating* Units from Power System Disturbances*unit transformer*

(a) A *generating unit* may be *disconnected* automatically from the *transmission* or *distribution system* in response to abnormal conditions arising from the behaviour of the *power system*. However, a *generating unit* must not be *disconnected* if the *power system* conditions at the *connection point* remain within the envelope described in clause 3.3.3.3 for continuous uninterrupted operation.

(b) The abnormal *conditions* referred to in clause 3.3.3.8(a) include:

(1) loss of synchronism;

(2) high or low *frequency* outside the *generator* off-nominal *frequency* operation capability requirements specified in Figure 3.4;

(3) sustained excessive *generating unit* stator current that cannot be automatically controlled;

(4) high or low stator *voltage* outside *generator machine* rating;

(5) voltage to frequency ratio outside generator machine rating;

(6) negative phase sequence current outside *generator machine* rating; and

(7) any similar condition agreed between the *Generator* and the *Network Service Provider* after consultation with *System Management*.

(c) The actual design and settings of the *protection equipment* installed in order to disconnect a *generating unit* in accordance with clause 3.3.3.8(a) must be consistent with *power system* performance requirements specified in section 2 and must be approved by the *Network Service Provider*.

3.3.3.9(a) Generating Unit *Transformer* impedance:

(a) Transformer Impedance:

The maximum permitted impedance of a *generating unit transformer* is 20% of the *generator's**Generator's* MVA rating.

(b) Vector Groupgroup:

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 Changingchanging:

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*.

3.3.3.103.3.15 De-energisation of *Generator* Circuitscircuits

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 3.2.23.2.2 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* ~~*or distribution*~~ *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* ~~*or distribution*~~ *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 ~~the *User*~~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).

~~**3.3.4 Monitoring and Control Requirements**~~

~~**3.3.4.1 Remote Monitoring**~~

~~(a) The Network Service Provider or System Management may require a User to:~~

~~(1) provide *remote monitoring equipment (RME)* to enable the *Network Service Provider* or *System Management* to monitor performance of a *generating unit* (including its *dynamic performance*) remotely where this is necessary in real time for control, planning or *security* of the *power system*; and~~

~~(2) upgrade, modify or replace any *RME* already installed in a *power station* provided that 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 *Generator* accordingly.

(b) Any *RME* provided, upgraded, modified or replaced (as applicable) under clause 3.3.4.1(a), must conform to an acceptable standard as agreed by the *Network Service Provider* and must be compatible with the *Network Service Provider's* and *System Management's SCADA system*.

(c) Input information to *RME* may include the following:

(1) Status Indications

(A) *generating unit* circuit breaker open/closed (dual point);

(B) remote *generation load* control on/off;

(C) *generating unit* operating mode;

(D) turbine control limiting operation; and

(E) connection to the transmission or distribution system;

(2) Alarms

(A) *generating unit* circuit breaker / main switch tripped by *protection*;

(B) prepare to off *load*; and

(C) *protection* defective alarms;

(3) Measured Values

(A) transmission system:

(i) gross active power output of each generating unit;

(ii) gross reactive power output of each generating unit;

(iii) net station *active power* import or export at each *connection point*;

(iv) net station *reactive power* import or export at each *connection point*;

(v) generating unit stator voltage;

(vi) generating unit transformer tap position;

(vii) net station output of *active energy* (impulse);

(viii) *generating unit* remote *generation* control high limit value;

(ix) *generating unit* remote *generation* control low limit value; and

(x) *generating unit* remote *generation* control rate limit value;

(B) distribution system:

(i) main switch *active power* import or export;

(ii) main switch *reactive power* import or export; and

(iii) *voltage* on the *Network Service Provider* side of main switch; and

(4) such other input information reasonably required by the *Network Service Provider* or *System Management*.

3.3.4.2 Remote control

(a) The Network Service Provider or System Management may, for any generating unit which may be unattended when connected to the transmission or distribution system, require the Generator to:

(1) provide remote control equipment (RCE) to enable the Network Service Provider or System Management to disconnect a generating unit from the transmission or distribution system; and

(2) upgrade, modify or replace any *RCE* already installed in a *power station* provided that the existing *RCE* is, in the opinion of the *Network Service Provider* or *System Management*, no longer fit for purpose and notice is given in writing to the relevant *User* accordingly.

(b) Any *RCE* provided, upgraded, modified or replaced (as applicable) under clause 3.3.4.2(a) must conform to an acceptable standard as agreed by the *Network Service Provider* and must be compatible with the *Network Service Provider's SCADA system*, including the requirements of clause 5.11.

3.3.4.3 Communications *Equipment*

(a) A *Generator* must provide communications paths (with appropriate redundancy) between the *RME* and *RCE* 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*. For *connections* to *distribution* system, this nominated location is in the *zone substation* from which the *distribution feeder* to which the *User* is *connected* emanates. Communications systems between this communications interface and the relevant *control centre* are the responsibility of the *Network Service Provider*, unless otherwise agreed.

(b) Telecommunications between the *Network Service Provider* and *Generators* must be established in accordance with the requirements set out below for *operational communications*.

(c) Primary Speech Communication Channel

(1) A *Generator* must provide and maintain a speech communication channel by means of which routine and emergency control telephone calls may be established between the *Generator's* responsible engineer or *operator* and *System Management* or the *Network Service Provider*, whichever is applicable.

(2) The speech communication channel provided must meet the requirements of the *Network Service Provider* and *System Management*.

(3) Where the public switched telephone network is to be used as the primary speech communication channel, a sole-purpose connection, which must be used only for operational communications, must be provided.

(d) Back-up Speech Communications Channel

(1) The *Network Service Provider* must provide a separate telephone link or other back-up speech communications channel for the primary speech communications channel.

(2) The *Network Service Provider* must be responsible for planning installing and maintaining the back-up speech communications channel, and for obtaining radio licenses if required.

(3) The *Network Service Provider* may recover the cost of providing the backup speech communications channel from the *generator* as agreed in the relevant *connection agreement*.

3.3.4.4 Frequency Control

(a) All *generating units* must have an automatic variable *load* control characteristic. *Turbine control systems* must include *facilities* for both speed and *load* control.

(b) *Generating units* must be capable of operation in a mode in which they will automatically and accurately alter *active power* output to allow for *changes* in the relevant *dispatch* level and for *changes* in *frequency* of the *transmission and distribution system* and in a manner to sustain high initial response.

(c) A *Generator* must, operate a *generating unit* in the mode specified in clause 3.3.4.4(b) unless instructed otherwise by *System Management* or the *Network Service Provider*, as the case requires.

(d) Dead band

The dead band of a *generating unit* (the sum of increase and decrease in *power system frequency* before a measurable *change* in the *generating unit's active power* output occurs) must be less than 0.05 Hz.

(e) Control Range

(1) For dispatchable generating units:

(A) The overall response of a *dispatchable generating unit* for *power system frequency* excursions must be settable and be capable of achieving an increase in the *generating unit's active power* output of not less than 5% for a 0.1 Hz reduction in *power system frequency* (4% droop) for any initial output up to 85% of rated output.

(B) A *dispatchable generating unit* must also be capable of achieving a reduction in the *generating unit's active power* output of not less than 5% for a 0.1 Hz increase in system *frequency* provided this does not require operation below the *technical minimum*.

(C) For initial outputs above 85% of rated *active power* output, a *generating unit's* response capability must be included in the relevant *connection agreement*, and the *Generator* must ensure that the *generating unit* responds in accordance with that *connection agreement*.

(D) *Thermal generating units* must be able to sustain *load changes* of at least 10% for a *frequency* decrease and 30% for a *frequency* increase if *changes* occur within the above limits of output.

(2) For *non-dispatchable generating units, a generating unit* must be capable of achieving a reduction in the *generating unit's active power* output for an

increase in system *frequency*, provided the latter does not require operation below *technical minimum*.

(f) Rate of Response

(1) For *dispatchable generating units*, for any *frequency* disturbance, a scheduled *generating unit* must achieve at least 90% of the maximum response expected according to the droop characteristic within 6 seconds for *thermal generating units* or 30 seconds for hydro *generating units* and the new output must be sustained for not less than a further 10 seconds.

(2) For *non-dispatchable generating units*, for any *frequency* disturbance, a *generating unit* must achieve at least 90% of the maximum response expected within 2 seconds and the new output must be sustained for not less than a further 10 seconds.

3.3.4.5 Voltage Control System

3.3.15.2 Main switch for *distribution connected large generating systems*

Each *facility* at which one or more *generating units* in a *large generating system*Note:

The overriding objective of a *generating unit's voltage control system* is to maintain the specified *voltage* range at the *connection point*.

(a) The excitation control system of a synchronous generating unit must be capable of:

(1) limiting the *reactive power* absorbed or supplied by the *generating unit* to within *generating unit's* capability for continuous operation given its *load* level;

(2) controlling the *generating unit's* excitation to maintain the short-time average *generating unit* stator *voltage* below its highest rated level (which must be at least 5% above the nominal stator *voltage*);

(3) maintaining adequate *generating unit* stability under all operating conditions and providing *power system* stabilising action if fitted with a *power system* stabiliser;

(4) providing a 5 second ceiling excitation *voltage* of at least twice the excitation *voltage* required to achieve maximum continuous *reactive power* rating at nominal *voltage* and at nominal *active power* output; and

(5) providing *reactive* current compensation settable for droop or remote point *voltage* control.

(b) Synchronous generating units must be fitted with fast acting excitation control systems in accordance with good electricity industry practice

(c) New non-synchronous generating units must be fitted with fast acting voltage and / or reactive power control systems in accordance with good electricity industry practice, which must be approved by the Network Service Provider.

(d) *Synchronous generating units* with ratings in excess of 30 MW or smaller *generating units* within a *power station* with a total *active power* output capability in excess of 30 MW must incorporate *power system* stabiliser (PSS) circuits which modulate the *generating unit* field *voltage* in response to *changes* in power output and/or shaft speed and/or any other equivalent input signal approved by the *Network Service Provider*. The stabilising circuits must be responsive and adjustable over a *frequency* range which must include *frequencies* from 0.1 Hz to 2.5 Hz. *Power system* stabiliser circuits may be required on *synchronous generating units* with ratings less than or equal to 30 MW or smaller *synchronous generating units* within a *power station* with a total *active power* output capability less than or equal to 30 MW if *power system* simulations indicate a need for such a requirement. Before commissioning of any *power system* stabiliser, the *Generator* must propose preliminary settings for the *power system* stabiliser, which must be approved by the *Network Service Provider*

(e) *Power system* stabilisers may also be required for *non-synchronous generating units*. The performance characteristics of these *generating units* with respect to *power system stability* must be similar to those required for *synchronous generating units*. The requirement for a *power system* stabiliser and its structure and settings will be determined by the *Network Service Provider* from *power system* simulations.

(f) The performance characteristics required for AC exciter, rotating rectifier and *static excitation systems* are specified in Table 3.1.

Table 3.1 Synchronous *generator excitation control system* performance requirements

Performance Item	**Units**	**Static Excitation**	**AC Exciter or Rotating Rectifier**	**Notes**
Sensitivity: A sustained 0.5% error between the *voltage* reference and the sensed *voltage* must produce an excitation *voltage change* of not less than 1.0 per unit.	Gain (ratio)	200 minimum	200 minimum	1
Field *voltage* rise time: Time for field *voltage* to rise from rated *voltage* to excitation ceiling *voltage* following the application of a short duration impulse to the *voltage* reference.	second	0.05 maximum	0.5 maximum	2, 4
Settling time with the *generating unit* unsynchronised following a disturbance equivalent to a 5% step *change* in the sensed *generating unit* terminal *voltage*.	second	1.5 maximum	2.5 maximum	3
Settling time with the *generating unit* synchronised following a disturbance equivalent to a 5% step *change* in the sensed *generating unit* terminal *voltage*. Must be met at all operating points within the *generating unit* capability.	second	2.5 maximum	5 maximum	3
Settling time following any disturbance which causes an excitation limiter to operate.	second	5 maximum	5 maximum	3

Notes:

1. 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). *Excitation control system* with both proportional and integral actions must achieve a minimum equivalent gain of 200.
2. Rated field *voltage* is that *voltage* required to give nominal *generating unit* terminal *voltage* when the *generating unit* is operating at its maximum continuous rating. Rise time is defined as the time taken for the field *voltage* to rise from 10% to 90% of the increment value.

3. Settling time is defined as the time taken for the *generating unit* terminal *voltage* to settle and stay within an error band of ±10% of its increment value.
4. Field voltage means generating unit field voltage.

(g) The performance characteristics required for the *voltage* or *reactive power control systems* of all *non-synchronous generating units* are specified in Table 3.2.

Table 3.2 Non-synchronous *generator voltage or reactive power control system* performance requirements

Performance Item	**Units**	**Limiting Value**	**Notes**
Sensitivity: A sustained 0.5% error between the reference *voltage* and the sensed *voltage* must produce an output change of not less than 100%of the *reactive power generation* capability of the *generating unit,* measured at the point of control.	Gain (ratio)	200 minimum	
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	
Small disturbance settling time: Settling time of the controlled parameter with the *generating unit connected* to the *transmission or distribution network* following a step change in the *control system* reference that is not large enough to cause saturation of the controlled output parameter. Must be met at all operating points within the *generating unit's* capability.	second	2.5 maximum	
***Large disturbance* settling time:** Settling time of the controlled parameter following a *large disturbance*, including a *transmission or distribution network* fault, which would cause the maximum value of the controlled output parameter to be just exceeded.	second	5 maximum	

Notes:

1. A control system with both proportional and integral actions must be capable of achieving a minimum equivalent gain of 200.
2. The controlled parameter and the point where the parameter is to be measured must be agreed and included in the relevant *connection agreement*.
3. Settling time is defined as the time taken for the controlled parameter to settle and stay within an error band of ±10% of its increment value.

(h) 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 excitation limiters, must be approved by the *Network Service Provider*.

(i) The structure and settings of the *voltage / excitation control system* must not be *changed*, corrected or adjusted in any manner without the prior written approval of the *Network Service Provider*.

(j) Control system settings may require alteration from time to time as advised by the *Network Service Provider*. The preliminary settings backed up by any calculations and system studies to derive these settings must be provided by the *Network Service Provider* at least two *months* before the system tests stated in clause 4.1.3 are undertaken. A *Generator* must cooperate with the *Network Service Provider* by applying the new settings and participating in tests to demonstrate their effectiveness.

(a) Excitation limiters must be provided for under excitation and over excitation of *synchronous generating units* and may be provided for *voltage* to *frequency* ratio. The *generating unit* must be capable of stable operation for indefinite periods while under the control of any limiter. 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.

(k) Limiters must not detract from the performance of any stabilising circuits and must have settings applied which are coordinated with all *protection systems*.

(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.

3.3.53.3.16 *Power station* Auxiliary *Transformers*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*.

3.3.63.3.17 Synchronising

(a) For a *transmission connected synchronous generating unit* the *Generator* must provide and install manual orautomatic synchronising at the *generating unit* circuit breakers.

(a)(b) For a *distribution connected synchronous generating unit* the *Generator* must provide and install automatic synchronising at the *generating unit* circuit breakers.

~~(b)~~(c) The *Generator* must provide check synchronising on all *generating unit* circuit breakers and any other circuit breakers, unless interlocked ~~(as outlined in clause 3.4),~~to the satisfaction of the *Network Service Provider,* that are capable of connecting the ~~*User's*~~*User's* *generating equipment* to the *transmission or distribution system*.

~~(c)~~(d) Prior to the initial *synchronisation* of the *generating unit(s)* to the *transmission or distribution* ~~transmission~~ *system*, the *Generator* and the *Network Service Provider* must agree on written operational procedures for *synchronisation*.

~~3.3.7~~3.3.18 Secure ~~Electricity Supplies~~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.

~~3.3.8~~3.3.19 Design ~~Requirements~~requirements for *Generator*'s ~~*Substations*~~*substations*

A *Generator* must comply with the requirements of clause ~~3.4.8~~3.4.8.

~~3.3.9 Computer Model~~

~~(a) A *Generator* must provide a software model of each *generating unit* suitable for use in the software package which is used by the *Network Service Provider* at the time of signing the relevant *connection agreement*. The model must automatically initialise its parameters from *load* flow simulations. Once a simulation case has been compiled, *changes* in the *load* flow such as *changes* in *voltage*, *generating unit* output, *voltage* set point must not require the study case to be recompiled. It is the preference of the *Network Service Provider* that the model be made available to the provider for inclusion in the standard software package library. The source code of the model must also be provided.~~

~~(b) *Generators* must demonstrate to the satisfaction of the *Network Service Provider* that the model adequately represents the performance of the *generating unit* over its *load* range and over the system *frequency* operating range of clause 2.2.1, Table 2.1. The normal method of model verification is through testing.~~

~~(c) The structure and parameter settings of all components of the turbine and excitation control *equipment* must be provided to the *Network Service Provider* in sufficient detail to enable the dynamics of these components to be characterised in the computer model for short and long term simulation studies. This must include a control block diagram in suitable form to perform dynamic simulations and proposed and final parameter settings for the turbine and *excitation control systems* for all expected modes of *turbine control system* operation. The final parameter settings must not be varied without prior approval of the *Network Service Provider*.~~

~~(d) The applicable structure and parameter settings include:~~

~~(1) speed/load controller;~~

~~(2) key *protection* and control loops;~~

~~(3) actuators (for example hydraulic valve positioning systems); and~~

(4) limiters.

(e) A *Generator* may connect to the *transmission or distribution system* without fully complying with the requirements of subclauses (a) to (d) of this clause 3.3.9 provided that the *Generator* agrees in the relevant *connection agreement* to alternative arrangements, acceptable to the *Network Service Provider*, for the provision of a compatible software model of the *generating unit* should the *Network Service Provider* upgrade or change its *power system* simulation software.

(f) A *Generator* that was *connected* to the *transmission or distribution system* prior to the *Rules commencement date*, and which has not fully complied with the requirements of subclauses (a) to (d) of this clause 3.3.9, must support the computer model for changes in the nominated software for the duration of its connection to the *transmission or distribution system*.

3.4 REQUIREMENTS FOR CONNECTION OF LOADS

3.4.1 Obligations of ~~*Consumers*~~*Users*

(a) For the purposes of section 3.4, references to *User* means a *User* that consumes electricity supplied through a *connection point.*

~~(a)~~(b) A ~~*Consumer*~~*User* must ensure that all *facilities* associated with the relevant *connection point* at all times comply with the applicable requirements and conditions ~~of~~for *connection* ~~for~~of *loads*:

(1) as set out in this ~~clause 3.4~~section 3.4; and

(2) in accordance with any relevant *connection agreement* with the *Network Service Provider*.

~~(b)~~(c) A ~~*Consumer*~~*User* must operate its *facilities* and equipment in accordance with any and all *directions* given by ~~*System Management*~~*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.

3.4.2 Overview

~~(a)~~ This clause ~~3.4~~3.4 applies to the *connection* of ~~*equipment* and~~ *facilities* and equipment of ~~*Consumers*~~*Users* to the *transmission and distribution systems*.

~~(b)~~(a) ~~The requirements set out in this clause 3.4 generally apply to the *connection* of a large *load* to the *transmission or distribution network*.~~ The specific requirements for the *connection* of a particular ~~*Consumer's equipment* and~~*User's* *facilities* and equipment must be determined by the *Network Service Provider* and will depend on the magnitude and other characteristics of the ~~*Consumer's*~~*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*.

~~(c)~~(b) A ~~*Consumer*~~*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*, ~~*System Management*~~*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 ~~*Consumer*~~*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~~*frequency* variations

A ~~*Consumer*~~*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 1.1.1.1(a) occur.

3.4.4 Power ~~Frequency Voltage Variations~~*frequency voltage* variations

A ~~*Consumer*~~*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 ~~clause 2.2.2~~clauses 2.2.2 and 2.2.3 occur.

3.4.5 Provision of ~~Information~~information

(a) Before *connection* to the *transmission or distribution system*, a ~~*Consumer*~~*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 ~~*Consumer's*~~*User's* *load* and that *connection* of the ~~*Consumer's*~~*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 ~~*Consumer*~~*User* in respect of a particular *connection point* will depend on characteristics of the ~~*Consumer's*~~*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 ~~*Consumer*~~*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 ~~*Consumer*~~*User* will only be required to provide the data referred to in clauses ~~3.4.5(b)(12)~~3.4.5(b)(12) and clause ~~3.4.5(b)(13)~~3.4.5(b)(13).

(c) In addition to the requirements in clause ~~3.4.5(a)~~3.4.5(a) and ~~(b),~~3.4.5(b), the ~~*Consumer*~~*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~~Attachment 3 and Attachment 9.

3.4.6 Design ~~Standards~~standards

(a) The equipment *connected* to a ~~Consumer's~~*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 voltages* and impulse levels specified by the *Network Service Provider*.

(b) The circuit breakers, fuses and other equipment provided to isolate a ~~Consumer's~~*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 ~~Consumer's~~*User's* *connection point* must coordinate with the equipment installed on the *power system*.

3.4.7 *Power factor* ~~Requirements~~requirements

(a) *Power factor* ranges to be met by *loads connected* to the *transmission system* and ~~those~~*loads* *connected* to the *distribution system* ~~and~~that are rated 1 MVA or more are shown in ~~Table 3.3.~~Table 3-10.

Table 3.-10 *Power factor* requirements for *loads*

Permissible Range	
Supply **~~Voltage~~*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
66 kV / 132 kV	0.95 lagging to unity
<66 kV	0.~~9~~90 lagging to 0.9 leading

(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* ~~and/or~~, *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 ~~electricity~~ *transmission and distribution system*.~~ ~~Adequate filtering *facilities* must be provided if necessary to absorb any excessive harmonic currents.

3.4.8 Design ~~Requirements~~requirements for ~~*Consumers' Substations*~~*Users' substations*

Equipment in or for any ~~*Consumer's*~~*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 ~~section~~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 ~~be~~ 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 ~~*Users*~~*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 Facilitiesfacilities*

3.4.9.1 *Consumers*General

(a) *Users* must provide automatic *load shedding facilities* where required by the *Network Service Provider* in accordance with clause 2.3.1(c).2.4(b).

(b) *Load shedding facilities* provided by a *User* that respond to under *frequency* events must only trip *loads* and not *generation* embedded within the *User's facility.*

3.4.9.13.4.9.2 Installation and Testingtesting of *Loadload shedding Facilitiesfacilities*

A *ConsumerUser* that controls a *load* subject to *load shedding* in accordance with clause 2.3.1(c)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 Requirementscontrol requirements

3.4.10.1 Remote Monitoringmonitoring

(a) The *Network Service Provider* may require large *transmission and distribution system connected Users* to:

(1) provide *remote monitoring equipment*, (*RME*) to enable *System ManagementAEMO* 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 *security of the power system security*; and

(2) upgrade, modify or replace any *RME* already installed in a *User'sUser'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 ~~*Consumer*~~*User*.

(b) An *RME* provided, upgraded, modified or replaced (as applicable) in accordance with clause ~~3.4.10.1(a)~~3.4.10.1(a) must conform to an acceptable standard as agreed by the *Network Service Provider* and must be compatible with the *Network Service Provider's SCADA system*, including the ~~requirements of clause 5.11.~~*nomenclature standards.*

(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~~communications equipment

Where *remote monitoring equipment* is installed in accordance with clause ~~3.4.10.1~~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~~electricity supplies

All *Users* must provide secure electricity supplies of adequate capacity ~~to provide~~ for the operation ~~for at least 8 hours~~ of equipment performing metering, communication, monitoring, and *protection* functions~~, on~~ 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~~3.5 apply only to a ~~*User's*~~*User's* *protection system* that is necessary to maintain *power system security. Protection systems* installed solely to cover risks associated with a ~~*User's*~~*User's* equipment are at the ~~*User's*~~*User's* discretion. The extent of a ~~*User's*~~*User's* equipment that will need to conform to the requirements of this clause ~~3.5~~3.5 will vary from installation to installation. Consequently, each installation will need to be assessed individually by the *Network Service Provider*. Information that may be required by the *Network Service Provider* in order to complete this assessment is specified in ~~Attachment 5.~~Attachment 5.

(b) The requirement for *protection systems* in respect of any ~~*User's*~~*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)~~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 ~~*Users'*~~*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*;

~~(1)~~(2) the use of *current transformer* and *voltage transformer* secondary circuits (or equivalent) of one party by the *protection system* of the other;

~~(2)~~(3) tripping of one party's circuit breakers by a *protection system* of the other party; and

~~(3)~~(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*~~*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*~~*User's* *protection systems* must be located on the relevant ~~*User's*~~*User's* equipment and must discriminate ~~with~~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 *Consumer's User's facility* is permitted only with the prior written agreement of the *Network Service Provider*.

(h) A *ConsumerUser* must not adjust their *protection* settings or otherwise modify its *protection* settings *systems*, including replacing associated *primary* or *secondary equipment*, without the *Network Service Provider's* approval.

3.5.2 Specific *Protection* Requirementsrequirements for *transmission connected* generating systems

3.5.2(a) Subject to clause 3.5.2(b), a *Generator* Facilitiesresponsible for a *generating system connected* to the *transmission system* must satisfy the *protection* requirements specified in this clause 3.5.2.

(a)(b) The requirements A *Generator,* responsible for a *generating system* that has an aggregate rated capacity of this clause 3.5.2 do not applyless than or equal to a *generation facility* where the total rating1 MVA, is comprised solely of all *inverter connected* generating units in that generating *facility* is less than 10 MW, and which areis *connected* to the *distribution system* at a nominal *voltage* below 66 kV. For that case,*transmission system* must satisfy the *protection system* requirements are specified in clauses 3.6 and 3.7this clause 3.5.3.

(b)(c) The protection system for a generating unit must be designed to protect the generating unit from faults on the transmission or distribution system and to minimise damage to the generating unit from infeeds from the transmission and distribution system in the event of an internal fault. The *main protection system* for a *generating unit* must incorporate *two fully independent protection schemes* of differing principle, each discriminating with the *transmission* and distribution *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.

(c)(d) The design of the *two fully independent protection schemes of differing principle* must make it possible to test and maintain either *protection scheme* without interfering with the other.

(d)(e) The *Generator's protection system* and other controls must achieve the following functions:

(1) disconnection of the *Generator's generation* from the *transmission and distribution systems* if any of the *protection schemes* required by clause 3.5.2(c) operate;

(2) separation of the Generator's generating unit from the transmission and distribution systems if there is a loss of supply to the User's installation from the transmission and distribution systems;

(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 ~~or distribution~~ system* except where a *Generator* is contracted under the *~~Market~~WEM Rules* to provide a black start *~~ancillary~~* service and is directed to provide this service by *~~System Management~~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 ~~3.3.3.10 or 3.5.1(d); and~~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 ~~User's~~User's 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)~~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.

~~(e)~~(f) A *Generator* must install check synchronising interlocks on all of ~~its~~their circuit breakers that are capable of out-of-*synchronism* closure, unless otherwise interlocked to the satisfaction of the *Network Service Provider*.

(g) ~~If~~ The *Network Service Provider* must develop a guideline detailing the performance requirements for anti-islanding systems for *large* generating *~~unit is~~systems connected* to the *transmission system.*

3.5.3 *Protection* requirements for *distribution connected generating systems*

3.5.3.1 Application~~*system the*~~

(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 ~~a circuit breaker close inhibit interlock with the feeder circuit breaker~~, as a minimum, the *protection* functions specified in this clause 3.5.3.2. *Protection* functions should respond to quantities measured at the

Network Service Provider's zone substation in accordance with the requirements specified *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:

(f)(1) are consistent with any guidelines developed by the *Network Service Provider*. ; and

do not reduce the abilityNote:

(2) This interlock is required in addition to the islanding 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 3.5.2(d)(3) on account2.2 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).potential safety hazard if a de-energised *distribution feeder*

was energised by an *embedded* For *generating unitsystems* 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.

(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 *disconnected* 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 *disconnected* 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) Unless it is supplying a *disconnected microgrid*, a *power station* must not *supply* power into any part of the *distribution system* that is *disconnected* 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 Specific Protection Requirements for Consumer Facilities~~

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 ~~*Consumer*~~*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~~2.9.4 unless a *critical fault clearance time* applies in accordance with clause ~~2.9.5~~2.9.5, in which case the required maximum *total fault clearance time* is the *critical fault clearance* time.

(b) If the ~~Consumer's~~*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 ~~3.5.3(a)~~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 ~~3.5.3(a).~~3.5.5(a). If a circuit breaker fails, the ~~*Consumer's*~~*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 ~~*UNITS*~~SYSTEMS TO THE TRANSMISSION OR HIGH *VOLTAGE* DISTRIBUTION ~~NETWORK~~ SYSTEM

3.6.1 Overview

This clause ~~3.6~~3.6 addresses the ~~particular~~ requirements for the connection of small *generating units* and ~~groups of~~ *small generating* ~~*units*~~*systems* of aggregate rated capacity ~~up~~less than or equal to ~~10 MW~~5 MVA (*small* ~~*power stations*) to the *distribution system* where such~~ *generating* ~~*units* are not subject~~*systems*) to ~~dispatch by *System Management* in accordance with~~ the ~~***minimum***~~*transmission system* ~~***conditions***~~or the *high voltage distribution system*. This does not apply to the connection of ~~*energy*~~*small generating systems* ~~rated at up to 10 kVA single phase, and 30 kVA three phase, *connected*~~ to the *low voltage* ~~system via inverters, in respect of which clause 3.7 applies.~~

~~**Note:**~~
~~The issues addressed by this clause 3.6 are:~~

~~1.~~(a) ~~the possibility that *generating units* embedded in~~ *distribution* ~~*systems* may affect the *quality of supply* to other *Users*, cause reverse *power transfer*, use up *distribution system* capacity, create a *distribution system* switching hazard and increase risks for operational personnel, and~~*system* (in which case either clause 3.7 or 3.8 applies).

(b) ~~the possibility that~~A *Generator* responsible for a *small* ~~*power station* or~~*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.

~~2.~~(c) A *Generator* responsible for a ~~number of~~ *small generating* ~~*units*~~*system connected to the high voltage distribution system* ~~could become islanded on to a part of the distribution system that has become *disconnected* from the *power system*, resulting in safety and *quality of supply* concerns.~~must comply at all times with *protection* requirements specified in clauses 3.5.1 and 3.5.3.

3.6.2 Categorisation of ~~***Facilities***~~***facilities***

(a) This clause ~~3.6~~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* ~~will~~shall apply at the *connection point*, rather than at the ~~*generator machine*~~*generating unit* terminals~~, except that the *reactive power* requirements for *synchronous generating units* will apply at the *generator machine* terminals.~~.

(c) In this clause ~~3.6~~3.6, *connection points* for *small* ~~*power stations*~~*generating systems* are characterised as:

(1) *transmission connected:* 3 phase, 66 kV, 132 kV, 220 kV or 330 kV; or

~~(1)~~(2) *high voltage distribution connected*: 3 phase, 6.6 kV, 11 kV, 22 kV or 33 kV~~; or~~.

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 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 3.6, 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 3.3.7.8(c) 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 3.3.7.9(c) 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 3.6.5(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* must ensure that the performance standards specified in clause 2.2 are met when a *small generating system* is *connected* to the *power system*.

(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 control, monitoring 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) *low voltage connected*: 1, 2 or 3 phase plus neutral, 240V or 415V.~~

(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

The *Generator* must comply with the testing and commissioning requirements for *generating units connected* to the *transmission or distribution system* specified in Attachment 12.

3.6.10 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 *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 units* and *small generating systems* 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.

(3)(c) Where a *small power stationgenerating 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) Modes of Operation

In thisThis clause 3.6,3.7 differentiates the mode of operation of arequirements applicable to *inverter connected* generating *unit* in a small *power station* is characterised as:

(1) being in continuous parallel operation*systems* with the *distribution system*, and either exporting electricity to the *distribution system* or not exporting electricityAS/NZS 4777.2 compliant *inverters* from those applicable to it;

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

(3)(1) being in short term test parallel operation with the *distribution system*, and either exporting electricity to the *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)(1) bumpless (make before break) transfer operation, being:

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

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

3.6.33.7.3 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 power stationgenerating system* as is reasonably required to ensure that the operation and performance standards of the *distributionpower system*, or other *Users,* are not adversely affected by the operation of the *power station*.*small generating system.* Details of the kinds of information that may be required are included in Attachment 10.Attachment 10. Where considered necessary by the *Network Service Provider* additional information of the kind included in Attachment 3Attachment 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 *equipmentgenerating system* on the operation and performance of the *distributionpower system* or on other *Users,* the *Network Service Provider* may require a *Generator* tomust provide data on:

(1) *power station* and *generating unit* aggregate real*active power* and *reactive power*; and

(2) flicker coefficients and harmonic profile of the equipment, where applicable and especially for wind power and inverter *connected 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;

(c)(1) Net import / export data must be provided in the form of:

(1)(A) a typical 24 hour power curve measured at 15 minute intervals (or better if available); and

(2)(A) details of the maximum kVA output over a 60 second interval,

or such other form as specified in the relevant *connection agreement*.

(3) When requested by the *Network Service Provider*, a *Generator* must provide details of the proposed operation of the equipment during start-up, shut-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*.

(d)(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*.

(e) For *generating units* in a small *power station* of aggregate rating 5 MW and above, the *Network Service Provider* must assess the need for dynamic simulation studies and may require the *Generator* to provide a computer model in accordance with the requirements of clause 3.3.9.

3.6.43.7.4 Safety and *Reliability*contribution to *power system reliability*

(a) The requirements imposed on a *Generator* by this clause 3.63.7 are intended to provide minimum safety and reliability standards forto protect the *distributionpower system* and other *User's* equipment. Safety, *power system reliability* and the *quality of supply* to other *Users*. Subject are paramount and *access applications* must be evaluated accordingly.

(a)(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 these requirements, aclause 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.

(b) The safety and *reliability* of the *distribution system* and the *equipment* of other *Users* are paramount and *access applications* must be evaluated accordingly. *Generators* must not connect or reconnect to the *distribution system* if the safety and *reliability* of the *distribution system* would be placed at risk.

(c)(a) Where it is apparent that the operation of equipment installed in accordance with the requirements of this clause 3.63.7 may nevertheless have an adverse impact on the operation, safety or performance of the *distributionpower 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.

(c) Unless otherwise agreed in the relevant *connection agreement*, the *Network Service Provider* may require a *Generator* not to operate equipment in abnormal *distribution* 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 ~~*Equipment* directly~~Technical requirements

(a) All *small generating systems* connected to the ~~*connection point* of a small *power station*~~*low voltage distribution system* via *inverters* must ~~be~~:

(1) ensure all *inverters* 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 ~~for the *maximum fault current* at the *connection*~~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 - *voltage* 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

(e) T(uv) means a point specified in clause 2.5.8(b).in time when the *voltage* first varied below 340 V before returning to between 340 V and 440 V.

(7) A *Generator* must ensure that the *maximum fault current* contribution from a 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 unit or small 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* station is capability

(2) 3.3.7.4 - *voltage* and *reactive power* control except:

(f)(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 of a magnituderesult in the *generating system* operating in a manner that will allowcauses the total fault current*voltage* at the *connection point* to exceed the levelslimits specified in clause 2.5.8(b) for all *distribution system* operating conditions.2.2.3.

3.6.5 Requirements of clause 3.3 applicable to small *power stations*

Table 3.4 lists specific provisions of clause 3.3 that apply to small *power stations* in addition to the requirements of this clause 3.6.

Table 3.4 Specific paragraphs of clause 3.3 applicable to *distribution-connected generating units* rated up to 10 MW

Clause	Requirement
3.3.3.1	Reactive power capability
3.3.3.3	*Generating unit* response to disturbances Except that *power stations* with less than 150 kVA aggregate capacity need not comply with subclauses 3.3.3.3(c) and 3.3.3.3(g) unless directed otherwise by the *Network Service Provider*.
3.3.3.8	Protection of generating units from power system disturbances
3.3.4.4	Frequency control systems

Clause	Requirement
	Except that *non-dispatchable induction generating units* need not comply with subclauses (a), (b), (d) and (e)(2) and f(2); and Except that non-synchronous power stations with less than 150 kVA aggregate capacity do not have to comply with subclauses (a), (b) and (d).
3.3.4.5	Voltage control systems Except that *non-synchronous generating units* may be fitted with *power factor* control systems utilising modern technology, unless *power system* studies show that fast acting *voltage* and / or *reactive power control systems* complying with clause 3.3.4.5(c) are required. Subclause 3.3.4.5(e) does not apply; and For power stations with a capacity of less than 150 kVA subclause 3.3.4.5(f) is replaced with: *Generating units* must have *voltage control systems* that ensure that the requirements of clause 3.6.8 are met at the *connection point*.

3.6.6 *Generating unit* characteristics

(a) To assist in controlling *distribution system* fault levels, *Generators* must ensure that *generating units* comply with the *Network Service Provider's* requirements relating to *minimum fault current* and *maximum fault current* contribution through a *connection point*.

(b) If the *connection* or *disconnection* of a *User's* small *power station* causes or is likely to cause excessively high or low fault levels, this must be addressed by other technical measures specified in the relevant *connection agreement*.

(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 3.3.7.8(c) 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 3.3.7.9(c) 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)

~~3.6.7~~3.7.6 *Connection* and ~~Operation~~ operation

~~3.6.7.1 Generators' Substations~~

3.7.6.1 ~~*Generators' substations* through which~~ Main switch

(a) Each *facility* at which one or more *generating units* in a *small* *generating* ~~*units* are~~*system* is *connected* to the *low voltage* *distribution system* must comply with the main switch requirements ~~of~~in clause ~~3.4.8.~~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

~~3.6.7.2 Main Switch~~

~~(a)~~ ~~Each *facility* at which a~~For a *synchronous* *generating unit* in a *small* ~~*power station* 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)~~(a) ~~Switches must be automatically operated, fault current breaking and making, ganged switches or circuit breakers. 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. It must be possible for the *Network Service Provider's* operational personnel to fit safety locks on the isolation point.~~

~~**Note:**~~
~~*Low voltage generating units* with moulded case circuit breakers and fault limiting fuses with removable links are acceptable for isolation points in accordance with subclause 3.6.7.2(c).~~

~~3.6.7.3~~ *generating system*~~Synchronising~~

(a) ~~For a *synchronous generating unit* in a small *power station*~~, 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*~~*User'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 *Generator* and the *Network Service Provider* must agree on written operational procedures for *synchronisation*.

~~3.6.7.4~~3.7.6.3 Safe ~~Shutdown~~shutdown without ~~External *Supply*~~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) 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*.

~~3.6.8~~3.7.7 Power ~~Quality~~quality and ~~*Voltage Change*~~*voltage change*

(a) A *Generator* must ensure that the performance standards specified in clause 2.2 are met when a *small generating system* is *connected* by it to the *power system*.

~~(a)~~ The *voltage step change* at the *connection point* for *connection* and *disconnection* must comply with the requirements of clause ~~2.2 are met when a small *power station* is *connected* by it to the *distribution system*.~~

~~(b)(a) The step *voltage* change at the *connection point* for *connection* and *disconnection* must comply with the requirements of clause 2.2.2.~~

> ~~**Note:**~~
> ~~These requirements may be achieved by synchronising individual *generating units* at intervals of at least two minutes.~~

(b) 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 ~~steady state~~requirements of clause 1.1.1.1(a) may be achieved by synchronising individual *generating units* at intervals of at least two minutes.

3.7.8 Remote control, monitoring and communications

~~(c)~~ For *generating systems* connecting to the *low* voltage ~~rise at the *connection point* resulting from export of power to the~~ *distribution system* via a non-*standard connection service*, the *Generator* must ~~not cause the *voltage* limits specified in clause 2.2 to be exceeded and, unless otherwise agreed~~comply with the ~~*Network Service Provider*, must not exceed 2%.~~

requirements of **Note:**

The 2% limit on the *voltage* rise specified in this clause 3.6.8 (c) may be waived if the *Generator* is contracted by the *Network Service Provider* for the provision of *voltage* control services. Such a waiver is most likely to be necessary at fringe of grid locations.

(d) When operating unsynchronised, a *synchronous generating unit* in a small *power station* must generate a constant *voltage* level with balanced phase *voltages* and harmonic *voltage* distortion equal to or less than permitted in accordance with either *Australian Standard AS* 1359 (1997) "General Requirements for Rotating Electrical Machines" or a recognised relevant international standard, as agreed between the *Network Service Provider* and the *User*.

3.6.9 Remote Control, Monitoring and Communications

(a) For *generating units* exporting 1 MVA or more to the *distribution system* the *Generator* must provide for:

(1) tripping of the *generating unit* remotely from the *Network Service Provider's control centre*;

(2) a close-enable interlock operated from the *Network Service Provider's control centre*; and

(3) remote monitoring at the *control centre* of (signed) MW, MVAr and *voltage*.

(b) For *generating units* exporting less than 1 MVA monitoring may not be required. However, where concerns for safety and *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 3.6.9(a).

(c) A *Generator* must provide a continuous communication link with the *Network Service Provider's control centre* for monitoring and control for *generating units* exporting 1 MVA and above to the *distribution system*. For *generating units* exporting below 1 MVA, non-continuous monitoring and control may be required e.g. a bi-directional dial up arrangement.

(d) A *Generator* must have available at all times a telephone link or other communication channel to enable voice communications between a small *power station* and the *Network Service Provider's control centre*. For *generating units* exporting above 1 MVA, a back-up speech communication channel pursuant to clause 3.3.4.3(d) may be required.

3.6.10 Protection

This clause 3.6.10 applies only to *protection* necessary to maintain *power system security*. A *Generator* must design and specify any additional *protection* required to guard against risks within the *Generator's facility*.

3.6.10.11.1.1.1 General

(a) A *Generator* must provide, as a minimum, the *protection* functions specified in this clause 3.6.10 in accordance with the aggregate rated capacity of *generating units* in a small *power station* at the *connection point*.

(b) 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.

(c)(a) A *Generator's protection system* must clear internal plant faults and coordinate with the *Network Service Provider's protection system*.

(d) 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* or designing the *protection system* to be fail-safe, e.g. to trip on failure.

(e) All *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*.

> **Note:**
> Clause 1.9.3(b) specifies the process whereby the *Rules* may be changed to include alternatives to the standards currently specified.

(f) All small *power stations* must provide under and over voltage, under and over *frequency* and overcurrent *protection schemes* in accordance with the *equipment* rating.

(g) All small *power stations* must provide earth fault *protection* for earth faults on the *distribution system*. All small *power stations connected* at *high voltage* must have a sensitive earth fault *protection scheme*.

> **Note:**
> The earth fault *protection scheme* may be earth fault or neutral *voltage* displacement (depending on the earthing system arrangement).

(h) All small *power stations* must provide *protection* against abnormal *distribution system* conditions, as specified in clause 3.3.3.8, on one or more phases.

(i) All small *power stations* that have an export limit shall have directional (export) power or directional current limits set appropriate to the export limit.

(j) All small *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 3.6.12.

(k)(a) Where synchronisation is time limited, the small *power station* must be *disconnected* by an independent timer

(l) *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 covered by this clause need not comply with subclauses (f) to (k) of this clause 3.6.10.1.

> **Note:**
> The above exemption from subclauses (f) to (k) of clause 3.6.10.1 recognises that the *rapid bumpless transfer* will be completed or the *generating unit* will be *disconnected* 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*.

3.6.10.2 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*.

3.6.10.3 Islanding *Protection*

(a) No small *power station* may supply power into any part of the *distribution system* that is *disconnected* 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*), 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* under all operating modes. The *Generator* must demonstrate that two different functional types of islanding *protection schemes* have been provided.

(c)(a) For *power stations* rated above 1 MVA, each functional type of islanding *protection scheme* must be incorporated into a physically separate *protection* relay. These may share the same *voltage* and current transformers but must be *connected* to different secondary windings. 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*.

(d) Except as provided in clause 3.6.10.3(c) where a *power station* is rated at less than 1 MVA the two islanding *protection schemes* may be incorporated into the same multi-function *protection* relay, provided that the overcurrent and earth fault *protection schemes* required by clauses 3.6.10.1(f) and 3.6.10.1(g) are in a physically separate relay.

(e)(a) Where there is no export of *power* into the *distribution system* and the aggregate rating of the *power station* is less than 150kVA, 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.

(f)(a) *Generating units* designed for *gradual bumpless transfer* must be protected with at least one functional type of loss of mains *protection scheme*.

(g)(a) 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.

3.6.111.1.1.1 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*.

3.6.12 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 of differing principle, 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.

clause 3.6.8.

3.6.133.7.9 Commissioning and Testingtesting

The *Generator* must comply with the testing and commissioning requirements for *generating units connected* to the *distribution system* specified in Attachment 12.Attachment 12.

3.6.143.7.10 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 *protection schemes* to ensure that operating limits and agreed import and export limits are not exceeded.

3.73.8 REQUIREMENTS FOR CONNECTION OF INVERTER ENERGY SYSTEMS CONNECTED TO THE LOW VOLTAGE DISTRIBUTION SYSTEM VIA INVERTERSA STANDARD CONNECTION SERVICE

3.7.1 Scope

3.8.1 Overview

(a) This clause 3.73.8 addresses the particular requirements for the connection of *inverter energy systems* to the *Network Service Provider's low voltage distribution system* via inverters. It covers installations rated up to 10 kVA single phase and 30 kVA three phase. For similarly rated non-inverter that can be *connected energy systems*via a *standard connection service*.

(a)(b) Where the *inverter energy system* requires a connection service other than a *standard connection service*, the requirements of clause 3.63.7 apply.

(b)(c) Nothing in this clause 3.73.8 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 2.22.2 will not be met as a consequence of the operation of the *inverter energy* systemsystems.

Note:

The scope of this clause 3.7 is limited to technical conditions of connection. The *Network Service Provider* is not able to enter an *energy* buyback agreement directly. A *User* wishing to enter into such an agreement must apply to a participating retailer. It should also be noted that whereas this clause 3.7 covers *connection* issues for *generators* up to 30 kVA, the maximum *generator* capacity for which a retailer may be prepared to enter into an *energy* buyback agreement may be less than this amount.

3.7.2 *Energy* System Capacity, Imbalance and Assessment

(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 *inverter energy systems connected* via *standard connection services* to determine the maximum *inverter energy system* capacity that can be *connected* while maintaining the *power system* performance standards specified in clause 2.2.

(a)(b) It is the responsibility of the *Network Service Provider* to carry out a connection assessment of the following *inverter energy* systems 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: operation of *inverters* at their rated output does **not** create an imbalance between individual phase to neutral *voltages* that exceeds the limits specified in the WA Electricity Regulations 1947:

(1) Single phase PV*inverter* connections rated greater than 5 kVA, and

(2) 415 V threeThree phase *inverter* connections with more than 2.5 kVA imbalance between any two phases.

(b)(c) Notwithstanding clause 3.7.2(a),3.8.2(b) the *Network Service Provider* may carry out the assessment of connections below these thresholds if it deems necessary.

(c) The *inverter energy system* must not cause a *voltage* rise across the service leads must not exceedthat exceeds 1% of the rated volts.

Note:

(d) Typical remedial measures include upgrade of the service leads and/or splitting the *generation* across all three phases, where applicable.connection *voltage*.

3.7.33.8.3 Relevant Standardsstandards

(a) The installation of primary inverter *energy* systems must comply with the relevant *Australian Standards* and international standards.

(b) Inverter systems must satisfy the requirements of *Australian Standard AS*/NZS 4777 "Grid connection of *energy* systems viaA *User* must only use *inverters*" as published and revised.

(c) The term 'inverter *energy* system' in these *Rules* has the same meaning as in *AS*/NZS 4777.

(d)(a) A that have a type-test report or type-testtest certificate from an independent and recognised certification body showing compliance of the *inverter* plant with AS/NZS 4777.2. Evidence of this must be supplied to the *Network Service Provider*. on request.

(e)(b) *Inverter energy systems* must be designed, installed and commissioned in accordance with relevant *Australian Standards* and *good electricity industry practice* and relevant *Australian Standards*.

(f) Should it be necessary to change any parameter of the *equipment* as installed and contracted, approval must be sought from *Network Service Provider*. Subsequently, the *Network Service Provider* will determine whether a revised application is required.

3.7.4 Metering Installation

(c) The *User* must make provision for an import/export meter, as Only *inverter energy systems* that have been assessed and approved by the *Network Service Provider*. shall be installed.

3.7.53.8.4 Safety

3.8.4.1 General

(a) Installations must comply with the relevant *Australian Standards* and all statutory requirements including *AS*/NZS 3000, *AS*/NZS 5033 and the *WA Electrical Requirements*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.

3.7.5.1 Labelling of switches

The *User's* installation must display warning labels in accordance with the *WA Electrical Requirements*. These labels must be maintained in good order.

(c) Any changes to any parameter on an installed *inverter energy system* must be approved by the *Network Service Provider*.

3.7.5.23.8.4.2 Security of operational settings

(a) Where operational settings are applied via a keypad or switches, adequate security must be employed to prevent tampering or, 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.

3.7.6 Circuit Arrangements

3.7.6.1 Schematic diagram

A durable single sided schematic wiring diagram of the installation showing all *equipment* and switches must be affixed on the site adjacent to The *Network Service Provider* may require the *User* to demonstrate that the operational settings implemented in the *inverter*.

3.7.6.2 Required switches

All switches must be suitably rated for the required duty. Figure 3.7 provides an example schematic diagram for connection of an *energy system* via an inverter to the network. The modes of operation are detailed in Table 3.5.

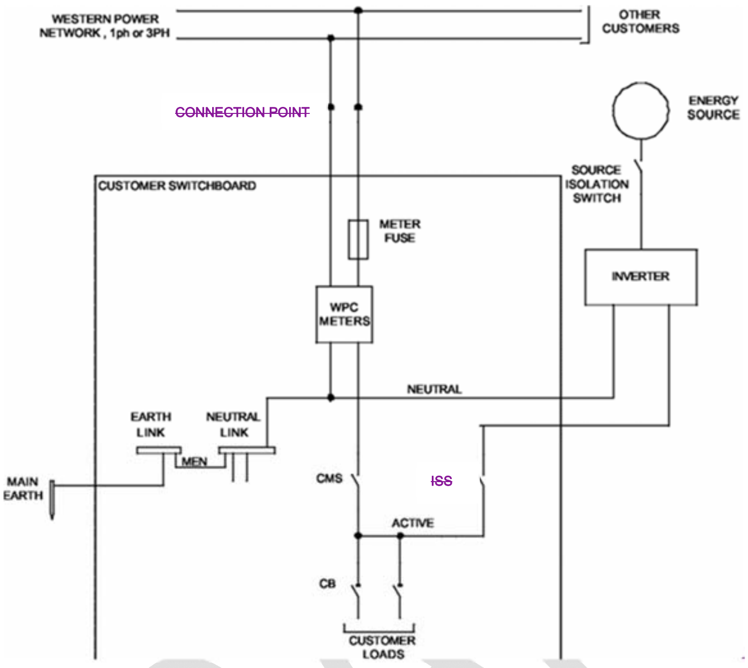


Figure 3.7 Schematic diagram for the connection of an inverter energy system

Table 3.5 Inverter energy system connection modes

User's Main Switch	Inverter Supply Switch	Operating Mode
Off	Off	All power off
Off	On	Supply to the User from the inverter only
On	Off	Inverter isolated from the Western Power network
On	On	Inverter connected to the network

(a) Main Switch

Normal *supply* must be provided through a suitably rated electromechanical main switch that isolates the entire installation from the *distribution system*.

(b) Inverter Supply Switch

A suitably rated inverter supply switch is required to isolate and protect the entire inverter energy system as shown in Figure 3.7. The inverter supply switch must be lockable in the OFF position.

It is preferable for the private generation source to be connected at the main switchboard. If this is not possible due to distance/cost considerations, the nearest sub board may be used.

(c) Source Isolation Switch

A Source Isolation Switch is required to isolate the energy source as shown in Figure 3.7. The source isolation switch must be rated for DC operation.

3.7.7 Protection

(b) An inverter *energy* system *connected* to the *distribution system* must bethose approved by the *Network Service Provider* and meet the requirements of relevant standards in accordance with clause 3.7.3 and the following requirements below. .

(a) The *User* must provide the information required by the *Network Service Provider* prior to approval being given.

(b) A *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 and the *connection agreement* at all times.

3.7.7.1 Islanding *protection*

The islanding function must be automatic and must physically remove the inverter *energy* system from the *distribution system*. The islanding *protection* must be capable of detecting loss of *supply* from the network and disconnect the inverter *energy* system from the *distribution system* within 2 seconds.

3.7.7.21.1.1.1 Synchronising

Connection to the *distribution system* must be automated. The protective apparatus must be capable of confirming that the *supply voltage* and *frequency* is within limits for no less than one minute prior to *synchronisation*.

3.7.7.3 Reconnection to network

Reconnection to the *distribution system* must be automated. The *protective apparatus* must be capable of confirming that the *supply voltage* and *frequency* are within limits for no less than one minute prior to *synchronisation*.

3.7.7.4 Overcurrent *protection*

(c) Overcurrent *protection* must be provided at the inverter *energy* system isolating switch in accordance with the *equipment* rating unless otherwise agreed with the *Network Service Provider*. with evidence of audited settings in response to any request made in accordance with clause 3.8.4.20.

3.7.7.5 Voltage limits

3.8.5 The inverter *voltage* limits must be set according to *equipment* capabilityConnection and *AS*/NZS 4777. However the operation

3.8.5.1 Main switch

(a) All *inverter energy* system must remain*systems* connected for *voltage* variations within the limits of Table 3. unless otherwise agreedto 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

To ensure the safe, reliable and secure operation of the *power system* the *Network Service Provider*. The network *voltage* range is based on 5-minute averages of the RMS value.

Table 3.6 Low Voltage Distribution System Voltage Limits

Nominal voltage	Lower limit	Upper limit
240 V	226 V	254 V
415 V	390 V	440 V

3.7.7.6 Frequency Limits

(a) The inverter *frequency* limits must be set according *equipment* capability and *AS/NZS 4777*. However the may specify an export limit for a *inverter energy system* must remain *connected* for *frequency* variations between 47.5 Hz and 52 Hz unless otherwise agreed withthat is less than the *inverter energy system* rated capacity.

(b) The *User* 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*.

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* 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.

3.8.6 Remote control and operation

(a) The *Network Service Provider* may specify additional requirements for *Users* to enable remote control and operation of an *inverter energy system*.

(b) Where additional requirements are specified under clause 3.8.6(a) the *User* must implement them.

3.7.83.8.7 Commissioning and Testingtesting

3.7.8.13.8.7.1 Exclusion of clause 4.1.3 and 4.2

Where it applies, this clause 3.7.8 applies to the exclusion of clause 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 3.8.7 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.

3.7.8.23.8.7.2 Commissioning

(a) Commissioning may occur only after the installation of the metering equipment.

(b) In commissioning equipment installed under this clause 3.73.8, a *User* must verify that:

(1) The approved schematic has been checked and accurately reflects the installed electrical system.

(2) All required switches present and operate correctly as per the approved schematic.

(3) Signage and labelling comply with the *WA Electrical Requirements*.

(4) The installation is correct and fit for purpose.

(5) Operational settings are secure ascommissioning requirement specified.

(6) The islanding *protection* operates correctly and disconnects the Inverter *energy* system from the network within 2 seconds.

(7)(b) The delay in reconnection following restoration of normal supply is greater than AS/NZS 4777.1 minute.

(c) Subsequent modifications to the *inverter* installation must be submitted to the *Network Service Provider* for approval.

3.7.8.33.8.7.3 Re-confirmation of correct operation

(a) The *Network Service Provider* may elect to inspect the proposed installation from time to time to ensure continued compliance with these requirements. 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 system* it may *disconnect* the *generating equipment*.the requirements in these *Rules*.

(b) To avoid doubt, clause 4.1.3 does not apply to *generators* covered by clause 3.7.

3.7.9 Signage

The *User* must provide signage as per the *WA Electrical Requirements*.

(b) In the event that the *Network Service Provider* considers that the installation does not meet the requirements of clause 3.5.1, 3.5.4 or 3.8, it may *disconnect* the *inverter energy system*.

4. *INSPECTION, TESTING, COMMISSIONING, DISCONNECTION AND RECONNECTION*

4.1 INSPECTION AND TESTING

4.1.1 Right of ~~Entry~~entry and ~~Inspection~~inspection

(a) ~~The *Network Service Provider*, *System Management* or any *User* whose *equipment* is *connected* directly to the *transmission system* and who is bound by these *Rules* (a reference to any of whom, for the purposes of this clause 4.1.1, includes its *representatives*)~~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* ~~which~~that the *Network Service Provider* or ~~*System Management*~~*AEMO* reasonably considers requires access to a *facility*, prior notice to the *facility* owner is not required. However, the *Network Service Provider* or ~~*System Management*~~*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~~, in the case of the *Network Service Provider* or *System Management*,~~ for the purpose of investigating an operating incident in accordance with clause ~~5.7.3.~~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(a)~~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 Testingtesting

(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 the *security* of the *power system*, *System Management 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, *System ManagementAEMO*, which agreement must not be unreasonably withheld or delayed.

(e) Tests under this clause 4.1.2 maymust 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 test 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 whichthat could have had an impact on the *security of the power system*, *System Management 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(i)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(i)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 Compliancedemonstrate compliance with *Connection* Requirements*connection* requirements for *generators*

4.1.3 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 ~~clause 3.3, or 3.6,~~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, ~~*System Management*~~*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.~~Attachment 11. The *Network Service Provider* must specify test requirements for ~~non-synchronous~~*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 ~~*System Management*~~*AEMO* where reasonably necessary to confirm that the ~~*security* and~~ 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.~~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*.

~~(3)~~(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 (NER) 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*.

~~(4)~~(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 days* before the tests or as otherwise agreed. The *Generator* must provide all necessary recorders and other measurement equipment for the tests.

~~(5)~~(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 ~~*System Management*.~~*AEMO*. The *Network Service Provider* or ~~*System Management*~~*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*.

~~(6)~~(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, or 3.6,~~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 ~~*unit*~~*system* is not complying with one or more technical requirements of clause ~~3.3~~3.3 and the relevant *connection agreement* then the *Generator* must:

(1) promptly notify the *Network Service Provider* ~~and, where relevant, *System Management*~~ of that fact;

(2) promptly advise the *Network Service Provider* ~~and, where relevant, *System Management* of~~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 *month*ly 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.

~~(d)~~(l) If the *Network Service Provider* or, where relevant, ~~*System Management*~~*AEMO* reasonably believes that a *generating unit* is not complying with one or more technical requirements of ~~clause 3.3 or 3.6, as applicable, and~~Chapter 3 or the relevant *connection agreement*, the *Network Service Provider* or ~~*System Management*~~*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 ~~*System Management*~~*AEMO* that requested the ~~test~~tests must reimburse the *Generator* for the reasonable expenses incurred as a direct result of conducting the tests.

~~(e)~~(m) If the *Network Service Provider* or, where relevant, ~~System Management~~*AEMO*:

(1) has reason to believe that a *generating unit* does not comply with one or more of the requirements of ~~clause 3.3 or 3.6, as applicable;~~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 ~~3.5.1(b);~~3.5; or

(3) either:

(A) does not have evidence demonstrating that a *generating unit* complies with the technical requirements set out in ~~clause 3.3~~Chapter 3; or ~~3.6, as applicable; 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, ~~*System Management*~~*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, ~~*System Management*~~*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.

~~(f)~~(n) If:

(1) the *Network Service Provider* or, where relevant, ~~*System Management*~~*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, ~~*System Management*~~*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 forto circumstances giving rise to the need for the *direction*,

then the *Network Service Provider* or *System ManagementAEMO*, as the case requires, may take such measures as are available to it (including, in the case of *System ManagementAEMO*, 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*.

(g)(o) A *direction* under clause 4.1.3(m) must be recorded by the *Network Service Provider* or *System ManagementAEMO*, as applicable.

(h)(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 *System ManagementAEMO* on request.

4.1.4 Routine Testingtesting of *Protection Equipmentprotection* 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'sUser's protection* at the *User'sUser'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 2.22.2, operates reliably and in accordance with its relevant performance requirements specified in sectionChapter 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 offor 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 *System ManagementAEMO* 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 sectionChapter 2.

4.1.5 Testing by *Users* of their own *Equipment* Requiring *Change*sequipment requiring *changes* to Agreed Operationagreed 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 days* 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 ~~*security of the*~~ *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 ~~*System Management*~~*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, ~~*System Management*~~*AEMO*, when the test is complete.

(g) If the *Network Service Provider* approves a proposed test, the *Network Service Provider* and, where appropriate, ~~*System Management*~~*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, ~~*System Management*~~*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 *Generatinggenerating* units Requiring *Changes*requiring changes to Agreed Operationagreed 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) TheFor *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*.

(e)(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~~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 ~~*System Management*~~*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 ~~*System Management*~~*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.

~~(d)~~(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.

~~(e)~~(f) Operational conditions for each test must be arranged by the *Network Service Provider* in consultation, where relevant, with ~~*System Management*~~*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.

~~(f)~~(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).

(g)(h) The *Network Service Provider*, following consultation where appropriate with *System ManagementAEMO*, 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.

(h)(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*USER'S EQUIPMENT

4.2.1 Requirement to Inspectinspect and Test *Equipment*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).4.2.1(a).

4.2.2 Co-ordination during Commissioningcommissioning

(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'sUser's* equipment.

(b) A *User* may request from the *Network Service Provider* to 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.* To avoid doubt,However, this clause 4.2.2(c)4.2.2(c) does not apply if clause 3.73.8 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* if applicable, 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* if applicable; and

(3) the *Network Service Provider* consider 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*protection* settings for *Equipment*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 *System Management**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**User's facility* are cleared without adverse effects on the *power system*.

4.2.4 Commissioning Programprogram

(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~~tests

(a) The *Network Service Provider* and ~~*System Management*~~*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 (NER) 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*~~*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'sUser'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'sUser'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*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'sUser'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 ProviderProvider'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 clauseChapter 33 of these *Rules*, or the *power system* not to comply with the performance standards specified in clause 2.22.2, 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 ServicesService Provider* reasonably determines that a setting of a *User'sUser's control system* or *protection system* needs to *change* in order for the *User* to comply with the requirements of clauseChapter 33 of these *Rules*, or for the *power system* to meet the performance standards specified in clause 2.2,2.2 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 3.53.5, 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*~~*User's* equipment with any new setting.

4.2.7 Approval of ~~*Proposed Protection*~~*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*~~*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 *Decommissioning* ~~Procedures~~procedures

(a) If a ~~*User's*~~*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*~~*disconnection*

(a) The *Network Service Provider* or ~~System Management~~*AEMO* may *disconnect* a ~~User's~~*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 ~~*System Management or the Independent Market Operator*~~*AEMO* in the exercise or purported exercise of a power under the ~~*Market*~~*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 ~~other Act or Regulation~~*written law*; or

(7) in accordance with ~~the User's~~any *connection agreement* relating to the *connection point*.

~~**Note:**~~

Note:
Disconnection in accordance with clause ~~4.3.4(a)(5)~~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).~~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~~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~~undertake works

(a) The *Network Service Provider* may, in accordance with *good electricity industry practice*, *disconnect* a ~~User's~~*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* Duringduring an Emergencyemergency

Where the *Network Service Provider* or *System ManagementAEMO* is of the opinion that it must *disconnect* a *User'sUser's facilities* during an emergency under these *Rules* or otherwise, then the *Network Service Provider* or *System ManagementAEMO*, 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'sUser's facility* by automatic or manual means; or

(b) immediately *disconnect* the *User'sUser's facilities* by automatic or manual means where, in the opinion of the *Network Service Provider* or *System ManagementAEMO*, as applicable, it is not appropriate to follow the procedure set out in clause 4.3.6(a)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 Reconnectreconnect

The *Network Service Provider* or System Management must reconnect a User'sUser's *facilities* to a *transmission or distribution* transmission *system* as soon as practicable:

(a) in the case of the *Network Service Provider*, where directed to do so by *System Management or the Independent Market OperatorAEMO* in the exercise or purported exercise of a power under the *MarketWEM 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 *System ManagementAEMO*, as applicable, that the breach will not re-occur.

5. *TRANSMISSION AND DISTRIBUTION SYSTEM OPERATION AND COORDINATION*

5.1 APPLICATION

This sectionChapter 5 applies to the operation and coordination of the *Network Service Provider's* and *Users*' *facilities* to the extent not covered under the *MarketWEM Rules*. For Market *Generators*Participants (as defined under the *MarketWEM 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 *MarketWEM 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 SectionChapter 5

(a) This sectionChapter 5, which applies to, and defines obligations for, the *Network Service Provider* and all *Users*, has the following aims:

(b)(1) to establish processes and arrangements to enable the *Network Service Provider* to plan and conduct operations within the *power system*; and

(c)(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 *Service Provider* *Operator*

5.3.1 The *Transmission Network Operator's* responsibilities for Operation Co- the operation and co-ordination of the *Power System*

(a) The *transmission system* or the *distribution system* operation co-ordination responsibilities of the *Network Service Provider* are to:

(a)(1) take steps to coordinate *high voltage* switching procedures and arrangements in accordance with *good electricity industry practice* in order to avoid damage to equipment and, to ensure the safety and *reliability* of the *power system*, and maintain *power system reliability, transmission network adequacy* and *power system security*;

(b)(2) operate all *equipment* and 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*;

(c)(3) assess the impacts of any technical and operational *constraints*limitations of all plant and equipment *connected* to the *transmission or distribution system* on the operation of the *power system*;

(4) subject to clause 5.3.2, to 5.3.1(a)(7):

(A) *disconnect User's*Users' equipment, or

(B) require a *User* to operate its equipment,

as necessary during emergency situations to facilitate the re-establishmentmaintain and restore secure and reliable operation of the *normalpower 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 *state in the* 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,

~~(d)~~ as necessary to maintain and restore secure and reliable operation of the *power system*;

~~(e)~~(5) coordinate and direct any rotation of *supply* interruptions in the event of a major *supply* shortfall or disruption; ~~and~~

~~(f)~~(6) investigate and review all major ~~*transmission and*~~ *distribution system* and *power system* operational incidents and to initiate action plans to manage any abnormal situations or significant deficiencies ~~which~~that could reasonably threaten safe and reliable operation of the ~~network~~*distribution system*. Such situations or deficiencies include:

~~(1)~~(A) *power system frequencies* outside those specified in the ~~definition of *normal*~~frequency operating ~~*state*~~standards specified in the *WEM Rules* and investigation or review is required to support an *AEMO* investigation under the *WEM Rules*;

~~(2)~~(B) *power system voltages* outside those specified in ~~the definition of *normal operating state*;~~clause 2.2.3;

(3)(C) actual or potential lack of *power system* instability; and*stability*;

(4)(D) unplanned or unexpected operation of major *power system* equipment.;

5.3.2 The *Network Service Provider's* Obligations

(a) The *Network Service Provider* must, in accordance with the *Access Code* (including through the provision of appropriate information to *Users* to the extent permitted by law and under these *Rules*), to fulfil its *transmission system* or the *distribution system* operation and co-ordination responsibilities in accordance with the appropriate *power system operating procedures* and *good electricity industry practice*.

(b) The *Network Service Provider* must make accessible to *Users* such information as:

(1) the *Network Service Provider* considers appropriate; and

(2) the *Network Service Provider* is permitted to disclose,

in order to assist *Users* to make appropriate market decisions related to open access to the *Network Service Provider's transmission and distribution systems* and, in doing so, the *Network Service Provider* must ensure that such information is available to those *Users* who request the information on a non-discriminatory basis.

(c)(7) The *Network Service Provider* must operate those parts of the *transmission and distribution system* that are not under the control of *System Management**AEMO* so as to ensure that the *power system* performance standards as specified in clause 2.2 or clause 6.2 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* Obligationsobligations

(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* *Service Provider or System Management**Operator* under clause 5.7.35.4.4.3, or the *Distribution Network Operator* under clause 5.5.3.3.

(c) A *User* must co-operate with and assist the *Network Service Provider or System Management**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 ~~Service Provider~~*Operator, Distribution Network Operator* or ~~System Management~~*AEMO*.

(e) A *User* must notify ~~*System Management*~~*AEMO* or, where appropriate, the *Transmission* Network ~~*Service Provider*~~*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 ~~*Service Provider*~~*Operator* at least 5 *business days* prior to taking a *protection* of *transmission* ~~plant~~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 ~~*Service Provider*~~*Operator* at least 5 *business days* prior to taking a *protection* of *distribution* ~~plant~~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.

~~5.4 CONTROL OF TRANSMISSION SYSTEM VOLTAGES~~

~~5.4.1 *Transmission and Distribution System Voltage* Control~~

(h) ~~The *Network Service Provider* must determine~~Unless otherwise agreed with the *Network Service Provider*, 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);

(6) a single section of busbar;

there must be no:

(7) *loss of demand* except as specified in Table 2-11;

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

(9) *unacceptable voltage conditions*; or

(10) *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) ~~in the control~~ 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:
~~(a)~~ 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* ~~*system voltages.*~~*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).

~~(b) The *Network Service Provider* must assess and determine the limits of the operation of the~~ If, at any time, there are insufficient *transmission* ~~*and*~~*or distribution system* ~~associated with the avoidance of *voltage* failure or collapse under *contingency event* scenarios. Any such determination must include a review of the *voltage stability* of the *transmission system*.~~

~~(c) The limits of operation of the *transmission system* must be translated by the *Network Service Provider* into key location operational *voltage* settings or limits, *transmission line* capacity limits, *reactive power* production (or absorption) capacity or other appropriate limits to enable their use by the *System Management* and, where appropriate, the *Network Service Provider* in the maintenance of *power system security*.~~

(d) The *Network Service Provider* must design and construct the *transmission and distribution system* such that *voltage* nominations at all *connection points* can be maintained in accordance with the technical requirements specified in section 2.

(e) In order to meet the requirements of clause 5.4.1(d), the *Network Service Provider* must arrange the provision of *reactive power facilities* and *power system voltage* stabilising *facilities* through:

(1) contractual arrangements for *ancillary services* with appropriate *Users*;

(2) obligations on the part of *Users* under relevant *connection agreements*; and

(3) provision of such facilities by the Network Service Provider.

(f)(a) *Reactive power facilities* arranged under clause 5.4.1(e) may include*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) synchronous generating unit voltage controls usually associated with tap-changing transformers; or generating unit AVR set point control (rotor current adjustment);

(2) synchronous condensers (compensators);

(3) static VAr compensators (SVC);

(4) static synchronous compensators (STATCOM);

(5) shunt capacitors;

(6) shunt reactors; and

(7) series capacitors.

5.4.2 *Reactive Power Reserve* Requirements

The *Network Service Provider* must ensure that sufficient *reactive power reserve* is available at all times to maintain or restore the *power system* to a *normal operating state* after the most critical *contingency event* as determined by previous analysis or by periodic contingency analysis by the *Network Service Provider*.

5.4.3 Audit and Testing

(1) The *Network Service Provider* must arrange, coordinate and superviserecall 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 *Users*, then commercial *Users* and finally industrial *Users*.

(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 ~~of appropriate tests~~reviews of significant operating incidents or deviations from normal operating conditions in order to assess the ~~availability and~~ adequacy of the provision ~~of *reactive power* devices to control and maintain~~ 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* 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 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 *Users*, then commercial *Users* and finally industrial *Users*.

(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* 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) PROTECTION OF 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*.

5.55.7 POWER SYSTEM EQUIPMENTOPERATING 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* and a *User* must cooperate with the *Network Service Provider* to develop a *User Operating Protocol* which 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*.

5.5.15.7.3 *Power System* Fault Levels*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 ~~5.5.1(a)~~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*.

~~5.5.2~~5.7.4 ~~Audit~~Protection audit and ~~Testing~~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 ~~*power system*~~ *equipment* and ~~*equipment*~~facilitate safe and secure operation of the *power system*. Such tests must be performed according to the requirements of clause 4.1.

~~5.5.3~~5.7.5 ~~Power Transfer Limits~~ Audit and testing of reactive power control equipment

The *Network Service Provider* must ~~not exceed~~arrange, coordinate and supervise the ~~*power transfer* limits specified in clause 2.3.8, and they must not require or recommend action which causes those limits to be exceeded.~~

~~5.5.4 Partial *Outage* of Power *Protection systems*~~

~~(a)~~ ~~Where there is an *outage*~~conduct of ~~one *protection scheme* of a *transmission element*, the *Network Service Provider* must determine, and where~~ appropriate~~, advise *System Management* of,~~ tests to assess the availability and adequacy of the ~~most appropriate action~~provision of *reactive power* devices 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)(1) to take the *transmission element* out of service immediately;~~

~~(3)(1) to install or direct the installation of a temporary *protection scheme*;~~

~~(4) to accept a degraded performance from the *protection system*, with or without additional operational measures or other temporary measures to minimise *power system* impact; 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 *Network Service Provider* determines that to leave the *transmission element* in service presents an unacceptable risk to *power system security*, the *Network Service Provider* must take the *transmission element* out of service as soon as practicable and advise *System Management* and any affected *Users* immediately this action is undertaken.~~

(c) The *Network Service Provider* must abide by any relevant instruction given to it by *System Management* in accordance the *Market Rules.*

(d) Any affected *User* must accept a determination made by the *Network Service Provider* under this clause 5.5.4.

5.6 POWER SYSTEM STABILITY CO-ORDINATION

5.6.1 Stability Analysis Co-ordination

The Network Service Provider must:

(a) ensure that all necessary calculations associated with the stable operation of the *power system* as described in clause 2.3.7 and used for the determination of settings of *equipment* used to maintain that stability are carried out; and

(b) coordinate those calculations and determinations.

5.6.2 Audit and Testing

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*.

5.7 *POWER SYSTEM SECURITY* OPERATION AND CO-ORDINATION

5.7.1 *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) If the *Network Service Provider* considers the circumstances advised to it under clause 5.7.1(a) to be a threat to *power system security*, the *Network Service Provider*, in consultation as necessary with *System Management*, 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 *Network Service Provider* requires.

(c) A *User* must comply with a *direction* given by the *Network Service Provider* under clause 5.7.1(b).

5.7.2 Managing Electricity *Supply* Shortfall Events

Note:

It is the responsibility of *System Management* under the *Market 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 *Network Service Provider* may be required to manage the rotation of *supply* interruptions in accordance with clause 5.3.1(e).

(a) If, at any time, there are insufficient *transmission* or *distribution supply* options available to *supply* total *load* in a *region* securely, then the *Network Service Provider* may undertake any one or more of the following:

(1) recall of:

(A) a distribution equipment outage;

(B) a transmission equipment outage where the item of transmission equipment is not under the direct control of System Management;

(2) disconnect one or more load connection points as:

(A) the *Network Service Provider* considers necessary; or

(B) directed by *System Management* in accordance with the demand control measures in the *Market 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) A *User* must comply with a direction given under clause 5.7.2(a)(3).

(c) If there is a major *supply* shortfall, the *Network Service Provider* must implement, to the extent practicable, *load shedding* across interconnected *regions* in the proportion and order set out in the operational plan established for that purpose under the *Market Rules*.

5.7.3 Review of Operating Incidents

(a) The *Network Service Provider* 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 *System Management*.

(b) A *User* must co-operate in any such review conducted by the *Network Service Provider* (including by making available relevant records and information).

(c)(a) 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.

(d) For cases where the Network Service Provider or System Management has disconnected a transmission system User, a report must be provided by the Network Service Provider to the User detailing the circumstances that required the Network Service Provider or System Management to take that action.

Note:

This requirement does not apply to the disconnection of a *User* from the *distribution system* due to the large number of *Users* involved. However, for large *Users connected* to the *distribution system*, this requirement may be included in a *connection agreement*.

(e) The *Network Service Provider* must provide to a *User* available information or reports relating to the performance of that *User's equipment* during *power system* incidents or operating condition deviations as that *User* requests.

5.8 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 *Market Rules*. *Outage* planning for Rule Participants is undertaken by *System Management* in accordance with clauses 3.18 to 3.21 of the *Market 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 Services 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 5.8(a)(1) relates.

(b)(a) 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 5.8(a)(1) is complied with, unless otherwise agreed with the *Network Service Provider*.

(d)(a) 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)(1) specify the work to be carried out during each such an *outage*;

(3)(1) be in writing in substantially the form requested by the *Network Service Provider*; and

(4)(1) be consistent with *good electricity industry practice*.

(e) If a *User* becomes aware that a maintenance schedule provided by the *User* under clause 5.8(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*.

5.9 POWER SYSTEM OPERATING PROCEDURES

5.9.1 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*, and the *Network Service Provider's* Electrical Safety Instructions and procedures.

(c)(a) 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*.

5.105.8 POWER SYSTEM OPERATION SUPPORT

5.10.15.8.1 Remote Controlcontrol and Monitoring Devicesmonitoring devices

(a) All remote control, operational metering and monitoring devices and local circuits as described in section 3Chapter 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 *System ManagementAEMO*.

5.10.2 *Power System Operational Communication Facilities*

(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 whichthat 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 3.3.4.3(c)3.3.10(c) or clause 3.6.9(d)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 *System ManagementAEMO* 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 5.10.2.(d)5.8.2(d) include position, telephone numbers, a facsimile number and an electronic mail address.

5.10.35.8.3 Authority of Nominated Operational Contactsnominated 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.

~~5.10.4~~5.8.4 Records of ~~*Power System Operational Communication*~~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*.

~~5.11~~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 ~~agreed~~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 ~~agreed~~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 ~~agreed~~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.

6. *DISCONNECTED MICROGRID AND STAND-ALONE POWER SYSTEM PERFORMANCE CRITERIA*

6.1 INTRODUCTION

This Chapter 6 describes the technical performance requirements of *disconnected microgrids* and *stand-alone power systems*, and the obligations of the *Network Service Provider* to allow these performance requirements to be achieved.

Section 6.2 specifies the performance standards that the *Network Service Provider* must seek to achieve when planning and operating their *disconnected microgrids* and *stand-alone power systems* excluding major *supply* disruptions, and when negotiating the *connection* of new *Users*.

A *User* should not rely on the performance standards specified in this section being fully complied with at a *connection point* under all circumstances.

Note: For the avoidance of doubt when elements, equipment and plant that comprises a *disconnected microgrid* are electrically *connected* to the *SWIS*, the equipment and plant forms part of the *distribution system* and all applicable requirements of these *Rules* as described for the *distribution system* apply.

6.2 DISCONNECTED MICROGRID AND STAND-ALONE POWER SYSTEM PERFORMANCE STANDARDS

6.2.1 *Frequency* variations

(a) The *frequency operating standards* that shall apply to *disconnected microgrids* and *stand-alone power systems* are defined in Table 6-1.

Table 6-1 *Frequency operating standards* for disconnected microgrids and stand-alone power systems

System description	Normal operation	Post contingency
Stand-alone power systems	47 to 52 Hz for 99% of the time over any 30 day period	Not applicable.
Disconnected microgrids	49 to 52 Hz for 99% of the time over any 30 day period	45 to 55 Hz
Parts of the *distribution system* that are islanded and supported by emergency response *generation*	47 to 52 Hz for 99% of the time over any 30 day period	Not applicable.
Note: When electrically *connected* to the *SWIS*, the equipment and plant that comprises a *disconnected microgrid* forms part of the *distribution system* and the *frequency operating standards* specified in section 2.2.1 of these *Rules* (which in turn reference the *WEM Rules)* apply. Notwithstanding the normal operation limits provided in Table 6-1 the *Network Service Provider* must use its best endeavours to operate as close to nominal *frequency* as reasonably practicable.		

(b) Where the *frequency operating standards* for *disconnected microgrids* identify the requirement to maintain *frequency* within certain bands post contingency, the ability to satisfy this requirement must be considered when planning and operating the *disconnected microgrid*.

(c) *Load shedding facilities* may be used to ensure compliance with the *frequency operating standards* for *disconnected microgrids* post contingency, where deemed necessary by the *Network Service Provider*.

6.2.2 *Voltage*

6.2.2.1 *Steady state voltage* limits

(a) The *steady state voltage* limits for a *disconnected microgrid* or *stand-alone power system* are as defined in section 2.2.3.1.

6.2.2.2 *Voltage step change* limits

(a) The *voltage step change* resulting from switching operations and contingencies on *disconnected microgrids* and *stand-alone power systems* must not exceed the limits given in Table 6-2 at *User* connection points that remain energised.

Table 6-2 *Disconnected microgrids and stand-alone power systems voltage step change* limits

Event	Post-event *voltage step change*
Stand-alone power systems routine switching[1]	+10 % to -10% of nominal *voltage*
Disconnected microgrid routine switching[2]	+6 % to -10% of nominal *voltage*
Unplanned formation of a *disconnected microgrid*	+10 % to -10% of nominal *voltage*

Notes:

(1) For example, motor starting.

(2) 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*.

6.2.2.3 Transient overvoltage limits

(a) The transient overvoltage limits for a *disconnected microgrid* or *stand-alone power system* are as defined in section 2.2.3.3.

6.2.3 Flicker

(a) The flicker planning levels for a *disconnected microgrid* or *stand-alone power system* are as defined in section 2.2.4.

(b) Clause 6.2.3(a) does not apply in *stand-alone power systems* where a *User* is directly responsible for flicker exceeding the stated limits.

6.2.4 Harmonics

(a) The harmonic planning levels for a *disconnected microgrid* or *stand-alone power system* are as defined in section 2.2.5.

(b) Clause 6.2.4(a) does not apply in *stand-alone power systems* where a *User* is directly responsible for harmonic distortion exceeding the stated limits.

6.2.5 Negative phase sequence *voltage*

The negative phase sequence *voltage* limits at all *connection points* for a *disconnected microgrid* are as defined in section 2.2.6.

6.2.6 Electromagnetic interference

Electromagnetic interference caused by equipment forming part of a *disconnected microgrid* or a *stand-alone power system* must not exceed the limits set out in Tables 1 and 2 of AS/NZS 2344 (2016).

6.2.7 Oscillatory stability

Oscillations in *active power*, *reactive power* or *voltage* should be sufficiently damped regardless of how they originate.

> **Notes:**
> For *disconnected microgrids*, there is no definition for sufficiently damped as the requirements to maintain stability will differ depending on the size of the system and will be determined by the *Network Service Provider* on a case by case basis.

6.2.8 *Voltage stability*

The *voltage* stability requirements for a *disconnected microgrid* are as defined in section 2.2.10.

6.3 OBLIGATIONS OF NETWORK SERVICE PROVIDER IN RELATION TO DISCONNECTED MICROGRID AND STAND-ALONE POWER SYSTEM PERFORMANCE

6.3.1 Flicker

(a) To ensure that the flicker level at any *point of common coupling* on a *disconnected microgrid* does not exceed the maximum levels specified in clause 6.2.3, the *Network Service Provider* must, where necessary and after consultation with the relevant *Users*, allocate flicker emission limits to *Users* in accordance with clause 6.3.1(b) and 6.3.1(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 6.3.1(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 *disconnected microgrid*. In verifying compliance, measurements of flicker must be carried out according to AS/NZS 61000.3.7 (2001).

6.3.2 Harmonics

(a) To ensure that the harmonic or interharmonic level at any *point of common coupling* on a *disconnected microgrid* does not exceed the maximum levels specified in clause 6.2.4, where necessary and after consultation with the relevant *Users*, the *Network Service Provider* must 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 *disconnected microgrid*.

(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.

6.3.3 Negative phase sequence *voltage*

(a) If the maximum level of negative phase sequence *voltage*, as specified in clause 6.2.5, is exceeded at any *connection point* on a *disconnected microgrid*, the *Network Service Provider* must remedy the problem to the extent that it is caused by the *disconnected microgrid*.

(b) If, in the *Network Service Provider's* opinion, the problem identified in clause 6.3.3(a) 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.

6.3.4 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 *disconnected microgrid* or *stand-alone power system*, and whether or not it exceeds the limits specified in clause 6.2.6. If the complaint is justified, the *Network Service Provider* must, as soon as reasonably practicable, take any necessary action to reduce the interference to below the maximum prescribed levels.

6.3.5 Assessment of *disconnected microgrid* and *stand-alone power system* performance

(a) The *Network Service Provider* must monitor the performance of *disconnected microgrids* and *stand-alone power systems* and ensure these systems are augmented as necessary so that the performance standards specified in clause 6.2 continue to be met irrespective of changes in the magnitude and location of *connected loads* and *generating units*.

> **Notes:**
> The cost of any upgrades to the equipment required as a result of additional *connected load* or *generating unit* conditions will be dealt with by commercial arrangements between the *Network Service Provider* and the *User*.

(b) The *Network Service Provider* must ensure that system performance parameter measurements for *disconnected microgrids* and *stand-alone power systems* comply with the performance standards specified in clauses 6.2.1 to 6.2.5 and are taken as specified in Table 6-3. Records of all test results must be retained by the *Network Service Provider* and made available to the *Authority* on request.

Table 6-3 Power quality parameters measurement

Parameter	Value measured	Frequency of measurement	Minimum measurement period	Data sampling interval
Fundamental *Frequency*	mean value over interval	In response to a complaint, or otherwise as required by the *Network Service Provider.*	one week for *stand-alone power systems*, all the time for *disconnected microgrids*	30 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* and *User's*

Parameter	**Value measured**	**Frequency of measurement**	**Minimum measurement period**	**Data sampling interval**
system performance during specific events.				

6.4 DISCONNECTED MICROGRID AND STAND-ALONE POWER SYSTEM PROTECTION

(a) *Disconnected microgrids* and *stand-alone power systems* must be designed, installed, and maintained in accordance with *written laws* and *good electricity industry practice*. To the extent reasonable and practicable, any relevant *Australian Standards* and International Electricity Commission (IEC) Standards should be followed.

(b) The *protection* requirements will vary from system to system. Consequently, the *protection* requirements of each *disconnected microgrid* and *stand-alone power system* will need to be assessed individually by the *Network Service Provider* to ensure that the fundamental *protection* principles of speed, selectivity, *sensitivity*, and stability are satisfied.

(c) All *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*.

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 application	The meaning given in the *Access Code*. [The definition in Unofficial Consolidated version of the Access Code, 18 September 2020, 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*. [The definition in Unofficial Consolidated version of the Access Code, 18 September 2020, 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 *Act*.
access application	The meaning given in the *Access Code*.
access servicescontract	The same meaning as "covered service"given in the *Access Code*. [The definition in Unofficial Consolidated version of the Access Code, 18 September 2020, 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*.]

accumulated synchronous time error	The difference between Western Australia Standard Time and the time measured by integrating the instantaneous operating *frequency* of the *power system*.
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.
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.
AEMO or Australian Energy Market Operator	The same meaning as "AEMO" or "Australian Energy Market Operator" in the *Access Code.*
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*.
ancillary service(s)	The same meaning as "covered service(s)" in the *Access Code*.
apparent power	The positive square root of the sum of the squares of the *active power* and the *reactive power*.
applicant	The meaning given in the *Access Code.* [The definition in Unofficial Consolidated version of the Access Code, 18 September 2020, 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 unit	A *generating unit* that is not a *synchronous generating unit.*
augment, augmentation	The meaning given in the *Access Code*. [The definition in Unofficial Consolidated version of the Access Code, 18 September 2020, 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 *backup 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 ~~common~~point of connection ~~point~~ between two or more circuits in a ~~power station substation or a transmission or distribution system~~ *substation*.
business day	The meaning given in the *Access Code*. [The definition in Unofficial Consolidated version of the Access Code, 18 September 2020, was: "**business day**" means a day that is not a Saturday, Sunday or public holiday throughout Western Australia.]
capability chart	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 *connection point*. The chart should show the *reactive power* capability achievable for any level of *active power* output while not exceeding limits necessary to prevent plant from damage or ensure stable operation.
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 *outages*, 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*. or a *stand-alone power 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*. For the avoidance of doubt, this also applies to a *stand-alone power system* where the *Network Service Provider's primary equipment* relates to the *generation* and energy storage equipment.
constant P & Q loads	A particular type of *load* model which does not change its respective MW and MVAr consumption as the system *voltage* or *frequency* varies.
constraint	AThe meaning given in the *WEM Rules*. [The definition in the WEM Rules, 1 July 2021, was: **Constraint**: Means: (a) a Network Constraint; and (b) a limitation onor requirement affecting the capability of a ***transmission or distribution system, load***Load or a generating ***unit preventing***system such that it from either transferring, consuming or generating the level of electric power which would otherwise be availablerepresent a risk to Power System Security or Power System Reliability if the limitation or requirement was removed..]
Consumer	A *User* who consumes electricity supplied through a *connection point*.
contingency event	An event affecting the *power system* whichthat the *Network Service Provider* expects would be likely to involve the failure or removal from operational service of a *generating unit* or, a *load*, *transmission*/ *element* or *distribution element*.

control centrecontinuous uninterrupted operation	A *facility* used by the *System Management* or *Network Service Provider* for directing the minute to minute operation of the *power system*.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.
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*.
controllable	for the purpose of clause 2.2.11, meansMeans that *voltages* at all major *busbars* 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.
controllerCo-ordinator of Energy	The same meaning as "designated *controller*"“Coordinator” in Appendix 3the Access Code. [The definition in Unofficial Consolidated version of the Access Code., 18 September 2020, was: “**Coordinator**” means the Coordinator of Energy referred to in section 4 of the Energy Coordination Act 1994.]
control systemcredible contingency	The means of monitoring and controllingA contingency that is considered for the operationpurposes of theassessing *power system security* and that must not result in the remaining *power system* being in breach of the stated planning or *equipment* including *generating units connected* tooperational 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 *distribution system*a *generating unit*.

converter coupled generating unit	A *generating unit* that uses *equipment* that *changes* the alternating-current power produced by the *generating unit* to alternating-current power acceptable for transfer to the *power system* at a *connection point*.
credible contingencyfault event	A single *contingency event* of oneAny of the following typesfault events can be considered as credible and initiate a *credible contingency*: (a) for *voltages* at 66kV 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, 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*; or (f)(e) a sudden *disconnection* of a system component, e.g. a *transmission line* or a *generation unit*..
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; and (b) unacceptable disturbance of *power system voltage* or *frequency*.
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.
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 to generating indefinitely and *disconnecting* 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 *System ManagementAEMO* to any *User* requiring the *User* to do any act or thing which the *Network Service Provider* or *System ManagementAEMO* 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*.
dispatchable generating unitdisconnected microgrid	A *generating unit* that, in its satisfactory normal operating state, is capable of closely controlling its real power output.A part or parts of the *SWIS* that is not an *embedded system* that is designed to be separated from the *SWIS*, has disconnected from the *SWIS* and is being operated independently from the *SWIS* by the *Network Service Provider.*
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.
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* or a *disconnected microgrid* or a *stand-alone power system.*
distribution feeder	AIn the *power system*, a *high voltage* radial circuit forming part of the *distribution system* that is supplied from a *zone substation*. In a *disconnected microgrid*, a *high voltage* radical circuit.
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 *voltages* 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* whichthat are *connected* to the networks when the normal *operating stateoperation* of the *power system* is disturbed.

embedded generating unitelectricity storage	A *generating unit* which supplies on-site *loads* or *distribution* system *loads* and is *connected* either indirectly (i.e. by means of the *distribution* system) or directly to the *transmission system*.A device consisting of 'storage works' as defined in the *Act*. [The definition in the *Act* as of 7 February 2021 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] 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*. For the avoidance of doubt, non-controllable energy storage such as a synchronous compensator or flywheel are not considered as *electricity storage*.
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	TheFor the *power system*, the operating conditions applying after a significant *transmission system 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.
equipment	A device used in generating, transmitting or utilising electrical *energy* or making available electric power.
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*. [The definition in the WEM Rules, 1 July 2021, was: **Essential System Services**: Each service 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* of the *generating unit* (including excitation limiting devices and any power system stabiliser).
extension	An *augmentation* that requires the connection of a power line or *facility* to the *transmission or distribution system*.

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; ~~(c)~~(d) *electricity storage;* and ~~(d)~~(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 ~~which~~that specify the *frequency* levels for the operation of the *power system*, *disconnected microgrids* and *stand-alone power systems* set out in ~~clause~~clauses ~~2.2~~1.1.1.1(a) and 6.2.1.
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*.
generating unit	The equipment used to generate electricity and all the related equipment essential to its functioning as a single entity.
generation	The production of electric power by converting another form of *energy* into electricity in a *generating unit*.

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 machineperformance standard	the machine used for the generation of electricity, excluding related or auxiliary *equipment*.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*.
good electricity industry practice	The meaning given in the *Access Code*. [The definition in Unofficial Consolidated version of the Access Code, 18 September 2020, 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 laws 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*.
Independent Market Operatorideal generator performance standard	The entity authorised under the *Electricity Industry (Wholesale Electricity Market) Regulations 2004* (WA) to administer and operate the Western Australia Wholesale Electricity Market.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*.
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.
inverter~~-coupled generating unit~~	A ~~*generating unit* which uses a machine,~~ device~~, or system~~ that ~~*changes* its direct-current~~uses semiconductor devices to transfer power ~~to alternating-current~~between a DC source or *load* and an AC source or *load* *Inverters* include AC to AC convertors transferring power ~~acceptable for *power system connection*~~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 batteries for *energy* 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 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*.
~~***maintenance conditions***~~***major augmentation***	The ~~operating conditions that exist when a significant element~~meaning given in the *Access Code*. [The definition in Unofficial Consolidated version of the ~~*transmission system*~~Access Code, 18 September 2020, 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 ~~the~~ are to be, part of a *distribution system* ~~has been taken out of service in~~ ; and (b) exceeds $30 million (*CPI adjusted*), where the *network assets* comprising the *augmentation* are, or are to be, part of: (i) a ~~planned manner so that maintenance can be carried out safely.~~*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 Rules***~~***market generator***	A *User* who is registered as a Market Generator in accordance with the *WEM Rules*.~~The Wholesale Electricity Market Rules established under the Electricity Industry (Wholesale Electricity Market) Regulations 2004 (WA).~~

maximum continuous current	The maximum current injected at the *connection point* when the *generating system* is delivering *rated maximum apparent power* and the *connection point voltage* is within the normal range.
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 and assuming current electricity consumption patterns.
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*.
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*.
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.
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*.
non-dispatchable generating unitmarket generation	AThe *generation* produced from *generating unit* that in its satisfactory normal operating state is not capable of closely controlling its real power outputor *generating system* operated by a *non-market generator*.
non-synchronous generating unitmarket generator	Any generating unit other than a directly connected synchronous generating unitA *generator* that is not a *market generator.*
normal operating statenon-scheduled generating system	Characterises operation when all significant elements of a *transmission system* are in service and operation is within the secure *technical envelope*.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) and supplied (exclusively or in part) from the following *zone substations*: Hay Street, Milligan Street, Wellington Street, Cook Street and Forrest Avenue(1). (1) Subject to a periodic review).
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.* This term is analogous to the 'Scheduled Outage' term used in 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	Has 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.
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*.
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.
power system reliability	The meaning given in the *WEM Rules*. [The definition in the WEM Rules, 1 July 2021, was: **Power System Reliability**: The ability of the SWIS to deliver energy within reliability standards while maintaining Power System Adequacy and Power System Security.]
power system security	~~The safe scheduling, operation and control of the *power system* on a continuous basis in accordance with the principles set out in clause 5 and the operating procedures of the *Network Service Provider* or *System Management*.~~The meaning given in the *WEM Rules*. [The definition in the WEM Rules, 1 July 2021, was: **Power System Security**: The ability of the SWIS to withstand sudden disturbances, including the failure of generation, transmission and distribution equipment and secondary equipment.]
power system stability	The ability of ~~an electric~~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 ~~which~~that conducts *power system load* or conveys *power system voltage*.
priority project	The meaning given in the *Access Code*. [The definition in Unofficial Consolidated version of the Access Code, 18 September 2020, 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*~~.~~, a *disconnected microgrid* or a *stand-alone power system*.
protection system	A system designed to *disconnect* faulted *primary equipment* from the *transmission or distribution system*, ~~which~~a *disconnected microgrid* or a *stand-alone power system* that includes one or more *protection schemes* and which also includes the *primary equipment* used to effect the disconnection.
quality of supply	With respect to electricity, technical attributes to a standard set out in clause ~~2.2~~2.2, 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	In relation to a *generating unit*, the maximum amount of *active power* that the *generating unit* can continuously deliver at the *connection point* when operating at its *nameplate rating*. In relation to a *generating system*, the combined maximum amount of *active power* that its *generating units* can deliver at the *connection point*, when its *generating units* are operating at their respective *nameplate ratings*.
rated maximum apparent power	In relation to a *generating unit*, the maximum amount of *apparent power* that the *generating unit* can continuously deliver at the *connection point* when operating at its *nameplate rating*. In relation to a *generating system*, the combined maximum amount of *apparent power* that its *generating units* can deliver at the *connection point*, when its *generating units* are operating at their respective *nameplate ratings*.
rated minimum active power	In relation to a *generating unit*, the minimum amount of *active power* that the *generating unit* can continuously deliver while maintaining stable operation at the *connection point* or another specified location in the *power system* (including within the *generating system*). In relation to a *generating system*, the combined minimum amount of *active power* that its in-service *generating units* can deliver at the *connection point* while maintaining stable operation.
reactive energy	A measure, in VAr hours (VArh)), of the alternating ex*change* 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	That *equipment*Equipment which is normally provided specifically to be capable of providing or absorbing *reactive power*, and includes the *equipment* identified in clause 5.4.1(f). 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 VArs. *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 bank*s, 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 compensator*s.
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*.
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 ~~*load*~~ 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.
~~***reliability***~~***registered generator performance standard***	~~A measure of the probability of *equipment* performing its function adequately for the period of time intended, under the operating conditions encountered.~~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*.

reliablerelevant generator modification	The expression of a recognised degree of confidence in the certainty of an event or action occurring when expected.A *potential relevant generator modification* that the *Network Service Provider* declares to be a *relevant generator modification.*
remote control equipment (RCE)	Equipment installed to enable the *Network Service Provider* to control a *generating unit* circuit breaker or other circuit breaker remotely.
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*).
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; or (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.
revisionrestart plan	The revision toOperational plan for restarting the *Rulespower system* following an amendment under sections 12.50 -12.54, or a review under section 12.56, ofsystem shutdown developed by *AEMO* in accordance with the *Access Code* and approval by the *AuthorityWEM Rules*.
rotor angle stabilityrevision	The ability of synchronous machines on an *interconnected power system* to remain in *synchronism* after being subjected to a disturbance, and which may comprise small-disturbance or transient stability, or both. Instability from a disturbance may occur in the form of increasing angular swings of some *generating units*, leading to loss of *synchronism* between *generating units*. Loss of *synchronism* can occur between one machine and the rest of the *power system*, or between groups of machines, with *synchronism* being maintained within each group after separating from each other.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.*
RTUrise time	A remote terminal unit installed within a *substation* to enable monitoring and control of *equipment* from a remote *control centre*.In relation to a *control system*, means the time taken for an output quantity to rise from 10% to 90% of the maximum *change* induced in that quantity by a step change of an input quantity.
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 ~~*System Management*~~*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 ~~unit~~system	A *generating* ~~unit which~~*system* that is *dispatched* by ~~System Management~~*AEMO*.
secondary equipment	Equipment within a *facility* or the electricity *transmission or distribution* ~~*systems*~~*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*. [The definition in Unofficial Consolidated version of the Access Code, 18 September 2020, was: **"service provider"**, in relation to a *network*, means a person who owns or operates the *network*.]
~~security~~settling time	~~The security of a *power system* is the degree of risk in its ability to survive imminent disturbances (contingencies) without interruption of service to *Users*. As it relates to the robustness of the system to imminent disturbances, it depends on the system operating condition as well as the contingent probability of disturbances.~~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.
~~sensitivity~~	~~In relation to *protection schemes*, has the meaning in clause 2.9.6.~~
~~service provider~~short circuit ratio	~~The meaning given in the *Access Code*.~~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*.
~~single contingency~~	~~In respect of a *transmission system*, a sequence of related events which result in the removal from service of one *transmission line*, *transformer* or other item of *equipment*. The sequence of events may include the application and clearance of a fault of defined severity.~~

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 disturbance rotor angle stability generating system	The ability of the powerA *generating* *system* with a total rated capacity less than or equal to maintain synchronism under small disturbances5 MVA.
small use customer	A *Consumer* that*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 Network or SWINinterconnected system (SWIS)	The meaning given in the *Act*. [The definition in the *Act* as of 7 February 2021 was: ***South West interconnected system*** means the interconnected *transmission and distribution systemsystems*, generating works and associated works — (c) located in the South West of the state of Western Australia,the State and extending from Geraldton togenerally between Kalbarri, Albany areas and across toKalgoorlie; and (d) into which electricity is supplied by — (i) one or more of the Eastern Goldfields, as defined in the *Act*.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*.
spinning reservestand-alone power system	Spinning *reserve ancillary service* as defined in the *Market Rules*, clause 3.9.The meaning given in the *Act*. [The definition in the *Act* as of 7 February 2021 was: ***stand-alone power system*** means the wires, apparatus, equipment, plant or buildings (including generating works, a *distribution system* and any storage works) — (a) which together are used, or to be used, for, or in connection with, or to control, the supply of electricity to a single customer or not more than a prescribed number of customers; and (b) which are not connected to another electricity network (other than that of the customer or customers)]

standard connection service	The meaning given 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.
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*.
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*.
supply transformerswitchable feeder section	A *transformer*, forming part of the *transmission system*, which delivers electricity to the *distribution system* by converting it from the *voltage* of the *transmission system* to the *voltage* of the *distribution system*.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.
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* which operate at the equivalent speed of the *frequency* of the *power system* in its normal operating condition.
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.
~~synchronous generating unit~~system strength	The ~~alternating current *generating units* which operate at~~ meaning given in the ~~equivalent speed~~*WEM Rules*. [The definition in the WEM Rules, 1 July 2021, was: **System Strength**: Is a measure of ~~the *frequency* 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.] 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 *system strength* the *voltage* at that location will be relatively sensitive to a disturbance, resulting in a *voltage* dip that is 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 ~~*system in its normal operating state*~~quality and *voltage stability*, and unstable interactions between *inverter*-based *generating units*.
~~System Management~~	~~The meaning given in the *Market Rules*.~~

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*.
technical envelope	The limits described in the *MarketWEM Rules*.
technical minimumtemperature dependency data	The minimum continuous *active power* output of a *generating unit*.A set of data defining the maximum achievable *active power* of a *generating system* or *generating unit* at a particular temperature. The data will be provided based on a template provided by the *Network Service Provider*. The data shows the *active power* capability achievable for any temperature while not exceeding limits necessary to prevent damage to plant or ensure stable operation.
terminal station	A *substation* that transforms electricity between two *transmission system voltages* and whichthat supplies electricity to *zone substations* but whichthat does not *supply* electricity to the *distribution system*.
thermal generating unit	A *generating unit* which uses fuel combustion for electricity *generation*.
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.
transfer capacity	System capacity from adjacent *demand groups* that can be made available within the times stated in Table 2-11.
transformer	-A piece of equipment that reduces or increases the *voltage* of alternating current.
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*.
transient rotor angle stability	The ability of the *power system* to maintain *synchronism* when subjected to severe disturbances, for example a short circuit on a nearby *transmission line*. The resulting system response involves large excursions of *generating unit* rotor angles and is influenced by the non-linear power-angle relationship.
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 the *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: (d)(a) an individual *transmission circuit* or a phase of that circuit; or (e)(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* *linecircuit* or an associated *substation*, which may include *transformers*, circuit breakers, *busbar*, *reactive equipment* and, *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 the *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 isare 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.
transmission system planning criteria	The criteria prepared byset out in section 2.5 of these *Rules* in accordance with the *Network Service Provider*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* which 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).
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.
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	Has the meaning given in clause 1.3(b)(3). 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). Available from: https://www.commerce.wa.gov.au/publications/wa-electrical-requirements-waer
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 ~~*distribution connected embedded*~~ *generating unit* connected to the *distribution system* supplies a fault current ~~which~~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 wholesale electricity market spanning the *SWIS* in Western Australia.
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:

~~(c)~~(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;

~~(d)~~(b) a reference to a person includes a reference to the person's executors, administrators, successors, substitutes (including persons taking by novation) and assigns;

~~(e)~~(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);

~~(f)~~(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*;

~~(g)~~(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;

~~(h)~~(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;

~~(i)~~(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;

~~(j)~~(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

~~(k)~~(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 ~~Code~~*Rules* require that *Users* submit technical data to the *Network Service Provider*. ~~This Attachment 3~~This Attachment 3 summarises schedules ~~which list~~listing the typical range of data ~~which~~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 ~~coded in categories,~~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~~Attachment 4 to ~~Attachment 10.~~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 ~~which~~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~~Data

Registered Data (R) consists of data validated and augmented prior to actual connection ~~a~~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 ~~a higher ranked code next to~~additional category identifiers against items ~~which~~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. ~~A~~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 ~~a~~any time ~~other than when that item would normally be reviewed or updated by submission to the *Network Service Provider* of the revised~~. Revised data must be submitted to the *Network Service Provider*, together with authentication documents~~, egotist~~ and supporting reports.

A3.4. Attachment 4Attachment 4 to Attachment 12,Attachment 12, cover the following data areas:

(a) Attachment 4 – Large *Generating Unit* Design Data.Attachment 4 – LARGE *GENERATING SYSTEM* DESIGN DATA. This comprises large *generating unitsystems* fixed design parameters.

(b) Attachment 5: - *Protection Systems* Design and Setting Data.(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* Setting Data.(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.Attachment 7 - *TRANSMISSION SYSTEM* AND EQUIPMENT TECHNICAL DATA OF EQUIPMENT AT OR NEAR *CONNECTION POINT*. This comprises fixed electrical parameters.

(e) Attachment 8 - *Transmission equipment* and Apparatus Setting Data.(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.(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 - *Design* Data For Small *Power Stations Connected* To The *Distribution System*.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 3.63.6 and 3.7 of the *Rules*.

(h) Attachment 11 – Test Schedule for Specific Performance Verification and Model Evaluation of Large *Generating Units*.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*.

(h)(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 large *generating units*small *power stations* covered by clause 3.33.6 and 3.7 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 3.3 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~~Attachment 4 and ~~6~~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 ~~with~~ 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 ~~this *non-synchronous*~~*asynchronous* *generating* ~~*unit*~~*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* ~~*UNIT*~~*SYSTEM* DESIGN ~~DATA[1]~~DATA[1]

Symbol	Data Description	Units	Data Category
	***Power station* technical data:**		
	Connection point to ~~Transmission~~*transmission* *system*	Text, diagram	S, D
	Nominal *voltage* at *connection point* to ~~Transmission~~*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

~~[1] Where applicable and unless requested otherwise, the data shall be provided at the site specific maximum ambient temperature.~~

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

~~* MVA base must be clearly stated.~~

~~Symbol~~	~~Data Description~~	~~Units~~	~~Data Category~~
	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
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	*Capability* ~~Chart~~*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 V curves	Graphical data Graphical data	R1 R1
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

~~Symbol~~	~~Data Description~~	~~Units~~	~~Data Category~~
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 *Change*r 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~~*Voltage* and speed		
	Leading *Reactive power* at rated MW	MVAr import	S, D, R2
	***Generating unit excitation control system*:**		

	***Generating unit* excitation 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
	***Generating unit* turbine / load controller (governor):**		
	Make		
	Model		
	General description of *turbine control system* (including block diagram transfer function & parameters)	Text, diagram	S, D
	Maximum Droop	%	S, D, R1

Symbol	Data Description	Units	Data Category
	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* 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
	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
	Steam Turbine Data:		
	(Multiple-Stage Steam Turbinesstage 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 c*ogeneration* 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

~~Symbol~~	~~Data Description~~	~~Units~~	~~Data Category~~
	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
	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 *Generator*s (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)		
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
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		
	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 Backup (*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	
	- ~~*Generator*~~*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*~~*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 ~~*generator*~~*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 ~~point of~~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	Units	Data Category
***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 ~~3.3.8.~~ 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~~rating**		
Nominal *voltage*	kV	S, D
Highest *voltage*	kV	D
Insulation ~~Co~~co-ordination		
Rated lightning impulse withstand *voltage*	kVp	D
Rated short duration power *frequency* withstand *voltage*	kV	D
Rated ~~Currents~~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~~configuration**

Operation Diagrams showing the electrical circuits of the existing and proposed main *facilities* within the ~~*User's*~~*User's* ownership including *busbar* arrangements, phasing arrangements, earthing arrangements, switching *facilities* and operating *voltages*.	Single line Diagrams	S, D, R1

***Transmission system* ~~Impedances~~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~~ circuit infeed to the ~~*Transmission*~~*transmission system*

Maximum *Generating unit* 3-phase short circuit infeed including infeeds from *generating units connected* to the ~~*User's*~~*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*~~*User's* *transmission system* at *connection point*.	% on 100 MVA base	D, R1
Minimum negative sequence impedance of ~~*User's*~~*User's* *transmission system* at *connection point*.	% on 100 MVA base	D, R1

***Load* ~~Transfer Capability~~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~~connecting embedded *generating units* to the ~~Transmission~~*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~~data for *~~Protection~~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~~change control data:		
Time delay settings of all *transformer* tap changers.	Seconds	D, R1
Reactive ~~Compensation~~compensation (including filter banks):		
Location and ~~Rating~~rating of individual *shunt reactors*	MVAr	D, R1
Location and ~~Rating~~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

Attachment 10 DISTRIBUTION SYSTEM *CONNECTED* GENERATORS UP TO 10 MW (EXCEPT INVERTOR-*CONNECTED* GENERATORS UP TO 30 KVA)

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 ~~3.6.2.3 of Technical Rules~~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, ~~generators~~*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 ~~*generator*~~*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* ~~generators~~*farms* (including flicker and harmonics) ~~to~~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 ~~Western Power~~the *Network Service Provider*, aggregate data required for performing stability studies undertaken in accordance with clause ~~3.2.16 & 3.3.3~~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 *voltage*s	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 ~~Generators~~[1]*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 ~~*generator*~~*generating system* only	kW-sec/rated kVA	D, R1
Inertia constant (H) for all rotating masses *connected* to the ~~*generator*~~*generating unit* shaft (for example, ~~generator,~~ 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

~~Synchronous Generators (continued)~~

Attachments		
Capability chart (~~Indicate~~Indicating effect of temperature and *voltage*)	Graphical data	S, D, R1

Notes:

1: A separate data sheet is required for each ~~generator.~~*generating unit*.

2: Where there is more than one ~~generator~~*generating unit*, the identifier should be the same as used on the single line diagram.

3: Base quantities must be clearly stated

*

Induction ~~Generators~~[1] *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
***~~Generator~~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 ~~generator~~*generating unit*.

2: Where there is more than one ~~generator~~*generating unit*, the identifier should be the same as used on the single line diagram.

3: Base quantities must be clearly stated.

***Inverter-~~Connected Generators~~[1]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 ~~generator~~[3]*generating system*[3]		S, D, R2
Long term flicker factor for ~~windfarm~~[3]*wind farm*[3]		S, D, R2
Harmonics current spectra[3]		S, D, R2

Notes:*

1: A separate data sheet is required for each ~~generator.~~*generating unit.*

2: Where there is more than one ~~generator~~*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 ~~slowly~~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 ~~A10~~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~~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 days* of completion of each test or test series.

(b) Where test results show that ~~*generator*~~*generating unit or generating system* performance does not comply with the requirements of these *Rules* or the *access contract* or *connection agreement* ~~it will be necessary to~~the *Generator* must rectify the problem(s) and ~~repeat tests~~the test must, unless otherwise be elected by the *Network Service Provider*, be repeated.

A11.7 Quantities to be Measured

~~(a)~~ (a) Wherever appropriate and applicable for the tests, the following quantities must be measured on the ~~machine~~*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:

~~*Generating*~~*Synchronous generating unit* and ~~Excitation System~~*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 ~~requested~~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*~~*power system* ~~Stabiliser~~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 i. 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 v. 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 (~~real~~*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 –55% step.

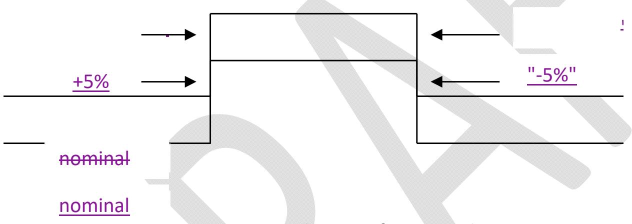


Fig A11.-1 - Application of step signal

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*~~*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 ~~tests~~test S10 equipment characteristics may require the *change*s be varied from the nominal values given. Larger *change*s 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.

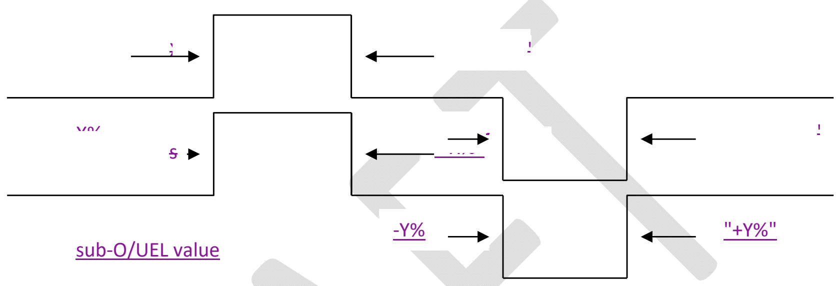


Figure A11.-2 - Application of Step Signal

ATTACHMENT 12 TESTING AND COMMISSIONING OF SMALL *POWER STATIONS CONNECTED* TO THE *DISTRIBUTION SYSTEM*

A12.1 Application

This attachment lists the specific ~~the~~ requirements for the certification, testing and commissioning of *generating ~~units~~systems*, connecting to the *distribution system* in accordance with ~~clause 3.6~~clauses 3.6 and 3.7 and for which the provisions of clause ~~4.2~~4.2 apply.

A12.2 Certification

The *Generator* must provide certification by a chartered professional engineer with National Engineering Register (NER) standing in relevant areas of expertise that the *facilities* comply with the *Rules*, the relevant *connection agreement*, *good* ~~engineering~~*electricity industry practice* and relevant standards. The certification must confirm that the following have been verified:

1. The single line diagram ~~approved by~~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* ~~network~~*system*;
4. The earthing systems ~~complies~~comply with *Australian Standards* ~~AS3000~~AS/NZS 3000 and ~~AS2067~~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 backup 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 ~~Services~~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~~*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 ~~*generator*~~*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 ~~Australian Standards AS3000~~AS/NZS 3000 and ~~AS2067~~AS/NZS 2067 and do not rely upon ~~he~~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~~*generating units*

- The *generating unit* is capable of specified sustained output of ~~real~~*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 backup 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* ~~engineering~~*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).
- 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.

- 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.

ATTACHMENT 14 BACKGROUND CONDITIONS FOR *TRANSMISSION* PLANNING

This Attachment sets out the background conditions used by the *Network Service Provider* when planning the *transmission system* in accordance with section 2.5 of these *Rules*.

For all scenarios, the *Network Service Provider* will assume *generation* is dispatched to meet the effective net system demand based on the principles relating to economic *dispatch* set out in the 'Generation Dispatch for Network Planning Guideline' (developed in consultation with *AEMO* as per clause 2.5.2(j)).

A14.1 System Security Background

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 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 *Network Service Provider* must meet the planning criteria set out in section 2.5 under this background condition and must invest in *transfer capacity* to facilitate compliance.

The System Security Background conditions planned for should include, as a minimum, system peak and minimum demand scenarios.

Given the different system limitations expected to occur at the above demand periods, the range of credible conditions and assumptions that should be adopted for study will also vary and should be developed by the *Network Service Provider.*

At a high level specific consideration is expected to include:

System Peak Demand

- System peak demand corresponding to **10% POE** forecast
- A credible *dispatch* aligned with 'Generation Dispatch for Network Planning Guideline' process for a System Security Background.
- Static reactive compensation plant at *transmission voltages* and *zone substations* set to maintain *voltages* within the normal operating range and ensure maximum reserves are maintained on dynamic reactive compensation and *generation.*
- Industrial and embedded *generation* outputs set to historic typical values at times of system **peak demand** to ensure typical net demand transfer.

System Minimum Demand

- System minimum demand corresponding to the **90% POE** forecast
- A credible *dispatch* aligned with 'Generation Dispatch for Network Planning Guideline' process for a System Security Background.

- Static reactive compensation plant at *transmission voltages* and *zone substations* set to maintain *voltages* within the normal operating range and ensure maximum reserves are maintained on dynamic reactive compensation and *generation*.
- Industrial and embedded *generation* outputs set to historic typical values at times of system **minimum demand** to ensure typical net demand transfer.

A14.2 System Economy Background

The intent of the System Economy Background is to ensure that there is an efficient level of *transmission* capacity to meet demand *reliability* and securely at typical system peak and minimum demand conditions, whilst minimising the impact of *constraints* on the *WEM*.

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.

Where there is sufficient economic justification then the *Network Service Provider* must seek to augment the network *transfer capacity*.

The principal focus is expected to be system peak demand, however there may be merit in studying an alternative demand period i.e., system minimum, in cases where new *generation* is expected to connect to the *transmission system* and may have an influence on system minimum demand characteristics different to that considered under the System *Security* Background.

Expected system conditions for study under the System Economy Background should be developed by the *Network Service Provider* in consultation with *AEMO* and are expected to include:

System Peak Demand

- System peak demand corresponding to **50% POE** forecast
- A credible *dispatch* aligned with 'Generation Dispatch for Network Planning Guideline' process for a System Economy Background.
- Static reactive compensation plant at *transmission voltages* and *zone substations* set to maintain *voltages* within the normal operating range and ensure maximum reserves are maintained on dynamic reactive compensation and *generation*.
- Industrial and embedded *generation* outputs set to historic typical values at times of system **peak demand** to ensure typical net demand transfer.

System Minimum Demand

- System minimum demand corresponding to **50% POE** forecast
- A credible *dispatch* aligned with 'Generation Dispatch for Network Planning Guideline' process for a System Economy Background.

- Static reactive compensation plant at *transmission voltages* and *zone substations* set to maintain *voltages* within the normal operating range and ensure maximum reserves are maintained on dynamic reactive compensation and *generation*.
- Industrial and embedded *generation* outputs should be set to historic typical values at times of system **minimum demand** to ensure typical net demand transfer.

ATTACHMENT 15 EXAMPLES OF DEMAND GROUPS FOR *TRANSMISSION* PLANNING

When considering the security of supply requirements of a section of the *transmission system*, and whether it can be operated in compliance with the requirements presented in Table 2-11, the *Network Service Provider* needs to identify the applicable *demand groups* that exist within the particular section of *transmission* network of interest.

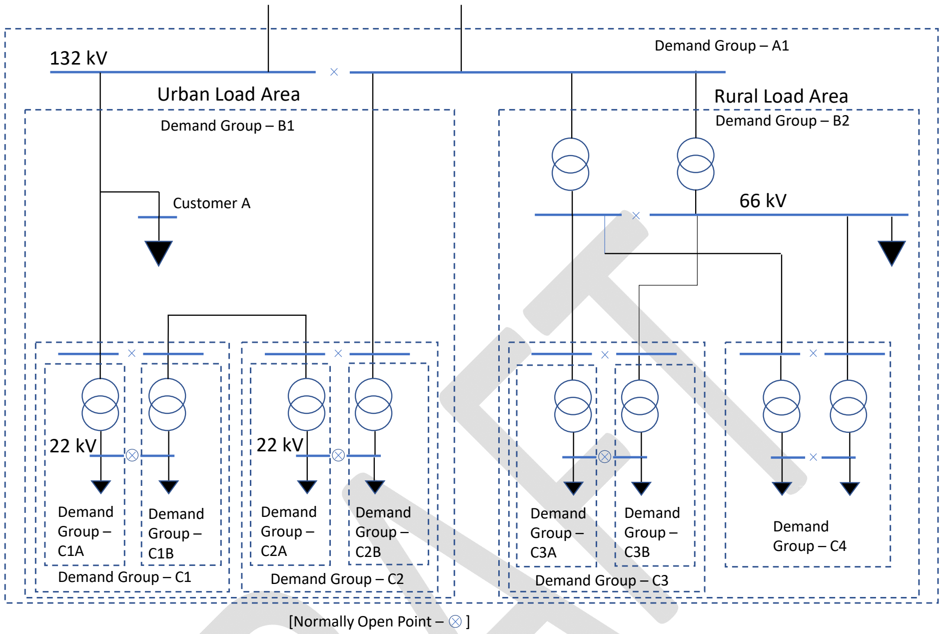
In general terms, a particular section of the *transmission* network will typically be composed of numerous demand groups, with lower *voltage* demand groups combining to form larger demand groups. This is illustrated in following Figure A15-1.

From a review of Figure A15-1 it is evident that the example section of the *transmission* network shown has the following characteristics:

- The network contains four individual demand groups (C1A/B, C2A/B, C3A/B and C4) relating to the *supply* of four *zone substations*.
- Three of the *zone substations* with split 22 kV *busbars*, i.e. C1A/B, C2A/B and C3A/B also sit within wider C1, C2 and C3 demand groups that cover the full *zone substation group demand*.
- The fourth *zone substation* has closed 22 kV *busbars* and hence the applicable *demand group* (C4) covers the full *substation load*.
- Two *zone substation* demand groups (C1 & C2) form part of a larger B1 *demand group* covering an urban *load* area, which also includes connection to Customer A.
- A second pair of *zone substation* demand groups (C3 and C4) form part of a larger B2 *demand group* covering a rural *load* area, including a customer *load* supplied at 66 kV.
- The whole section of the *transmission* network, including demand groups B1 & B2 forms part of an overall *demand group* A1

The following sections provide a number of examples that demonstrate how *group demand* should be calculated and also whether in the particular examples themselves the *transmission* network would be compliant with the planning requirements detail in Table 2-11.

Figure A15-1 Typical demand groups within a section of *transmission* network



A15.1 *Group demand* example 1

This example considers Demand Groups C1(A/B) and C2(A/B) from the wider Demand Groups A1 and B1 shown in Figure A15-1.

Consider the following characteristics for Demand Groups C1(A/B) and C2(A/B):

- Each is supplied by a *zone substation* with 2 x 30 MVA 132 / 22 kV *transformers*,
- Each *substation* has two 22 kV switchboards that share the *load* evenly but are normally open i.e. split,
- Each *zone substation* has 22 MW (24 MVA) of demand, 11 MW on each switchboard,
- No embedded *generation* is *connected* at 22 kV within either *substation*,
- *Transfer capacity* to neighbouring substations out with *Demand Group* B1 is 25 MW,
- A three ended circuit supplying *demand group* C1A/B also supplies Customer A, who has agreed to a single circuit *supply*.

The *security* of *supply* of the demand at each *substation* can be summarised by the following scenarios.

As the 22 kV switchboards are operated split at each *zone substation*:

1. The loss of an incoming 132 kV overhead line (from the upstream 132 kV *substation*) supplying either *zone substation* will not result in any *loss of demand* – provided that the *interconnection* at 132 kV to the neighbouring *substation* can *supply* the full *load*,
2. The loss of one *zone substation transformer* at either *substation* will result in a *loss of demand*, until one of the following actions is taken:
   - The 22 kV switchboards are operated closed,
   - The *load* supplied from the lost *zone substation transformer* can be transferred to the remaining healthy *transformer* or the neighbouring *zone substation transformers* through the *distribution* network,
   - The lost *zone substation transformer* is returned to service, either through repair or replacement.

Reviewing the requirements of Table 2-11, the following conclusions can be made with regards to whether the above scenarios are compliant with the planning criteria.

- The requirements related to Urban demand groups apply as per Table 2-11.
- In relation to scenario 1, as the total demand in each *Demand Group* C1 (including C1A and C1B) and C2 (including C2A and C2B) is <90 MVA each, with the initial conditions of an *intact system* then following the loss of an incoming *transmission* line from the upstream 132 kV *substation* the permitted demand is "None". That is, there must be no *loss of demand*. As noted, provided the *transmission* circuit connection to the neighbouring *zone substation* will allow the full *substation load* to be met, this design is compliant with the planning criteria. However, if there was a limitation in the *transfer capacity* at 132 kV of either the interconnecting *transmission* circuit e.g. 15 MVA or the incoming *transmission* circuit from the upstream 132 kV *substation* e.g. 35 MVA, then this would not be compliant with the planning criteria as the remaining 132 kV *transmission system* would not be capable of supplying the total *Demand Group* C1 and C2 *load* (48 MVA).
- For scenario 2, following the loss of a *zone substation transformer* demand will be lost until restoration actions are taken. As per Table 2-11, as the *zone substation load* on each switchboard (12 MVA) is in an urban area and <60 MVA, then with the initial conditions of an *intact system* following the loss of a *zone substation transformer* the demand may be loss for the duration of "remote switching". This is intended to be switching performed from the *Network Service Provider control centre* and will allow the *transformer* on *outage* to be remotely isolated (if this has not already happened through associated *protection* system operation) and the 22 kV switchboard to be reconfigured by closing the interlinking circuit breaker or any interconnecting 22 kV feeders. If these actions can be undertaken remotely then each of the *substation* Demand Groups C1A/B & C2A/B would be compliant with the planning criteria.

  However, if either of the Demand Groups C1A/B or C2A/B is supplied from a *substation* that does not have remote 22 kV switching capability, the loss of a *zone substation transformer* would not be compliant with the planning criteria.
- In relation to Customer A, as they have agreed to a single circuit *supply* risk then following the *outage* of the three end circuit supplying *Demand Group* C1, the *supply* to Customer A is considered to be immediately restored.

A15.2 *Group demand* example 2

This example considers *Demand Group* C3(A/B) which is within wider Demand Groups B2 and A1 shown in Figure A15-1.

Consider the following characteristics for *Demand Group* C3:

- The *substation* is supplied via 2 x 30 MVA 66 / 22 kV *transformers*,
- Each 66 kV *busbar* at the *zone substation* is supplied via a 66 kV overhead line from a terminal *substation*, with each line supplied from a different 66 kV *busbar* section at the terminal *substation*,
- The 66 kV *busbars* at the *zone substation* and terminal *substation* are operated closed i.e. in parallel,
- The *substation* has two 22 kV switchboards that share the *load* evenly but again are operated open under normal conditions i.e. split.
- No embedded *generation* is *connected* at 22 kV,
- There is no *transfer capacity* from other substations,

The *security of supply* of the demand at the *substation* can be summarised by the following scenarios.

1. The loss of an incoming 66kV overhead line will not result in a *loss of demand* unless the remaining 66 kV line cannot *supply* the C3 *group demand* in full i.e. the combined C3A and C3B demand.

   If the remaining 66 kV overhead line cannot *supply* the C3 *group demand* in full, then demand will be lost until the overhead line on *outage* is returned to service either through repair or replacement. Note that there is no *load* transfer to other zones substations.

2. The loss of one *zone substation transformer* supplying either *demand group* C3A or C3B will result in a *loss of demand* until one of the following actions is taken:
   - The 22 kV switchboards are operated closed and the combined C3A/B *group demand* is supplied via the remaining *transformer*,
   - The *zone substation transformer* that experienced the *outage* is returned to service, either through repair or replacement.

   Note that if the remaining *zone substation transformer* cannot *supply* the full combined C3A/B *group demand* then there will still be some *loss of demand*.

Reviewing the requirements of Table 2-11, the following conclusions can be made with regards to whether the above scenarios are compliant with the planning criteria.

- The requirements related to Rural demand groups apply as per Table 2-11:
- In relation to scenario 1, if the total C3 *group demand* is < 20 MVA then starting with the initial conditions of an *intact system*, following the loss of an incoming *transmission* line the C3 *group demand* can be lost for the duration of the "repair time" of the overhead line. So even if the remaining 66 kV overhead line in service was unable to *supply* the C3 *group demand* (combined C3A and C3B demand), this would still be compliant with the planning criteria.

However, if under scenario 1 the total C3 *group demand* was > 20 MVA then starting within an *intact system*, following the loss of an incoming *transmission* circuit no *group demand* is permitted to be lost. If the remaining 66 kV overhead line in service is able to *supply* the total C3 *group demand* then this meets the planning criteria requirements. However, if the 66 kV line has limited capacity and is unable to *supply* the total C3 *group demand*, then this would not be compliant with the planning criteria.

- Under scenario 2, the loss of a *zone substation transformer* will result in a *loss of demand* until either the affected *transformer* is repaired or replaced or the 22 kV switchboard is operated closed. If the C3A or C3B *group demand* is < 10 MVA, based on Table 2-11, the requirement is to restore *group demand* with the "repair time" for the failed *transformer*.

  However, if the C3A (or C3B) *group demand* was ≥10 MVA, then the *group demand* must be restored through "remote switching" following the *outage* of a *zone substation transformer*.

  Additionally, based on Note 1 following Table 2-11, if the contingency involves a *zone substation transformer* and the demand loss is > 20 MVA but < 60 MVA, then demand can be lost for up to 30 seconds. This will be sufficient time to perform remote switching and close the 22 kV circuit breaker between the two 22 kV switchboards to restore supplies. However, if this switching cannot be performed within the 30 seconds time frame then this would not be compliant with the planning criteria.

A15.3 *Group demand* example 3

This example considers *Demand Group* C4 which is within wider Demand Groups B2 and A1 shown in Figure A15-1 and is similar to the *Demand Group* C3 example except that the 22 kV *zone substation* switchboards are operated close i.e. in parallel.

This *change* in 22 kV switchboard configuration has the impact that the total *zone substation load* is now considered as one *demand group* (C4) as parallel assets i.e. two *zone substation transformers*, two 66 kV *busbar* sections and incoming 66 kV overhead lines, *supply* the entire combined C3A & B *group demand*.

In terms of the impact of this revised 22 kV switchboard configuration:

1. The *security* of *supply* of the C4 *group demand* with respect to incoming 66 kV overhead line capacity is the same as detailed for the C3 *demand group* as the 66 kV configuration is the same.
2. The loss of one *zone substation transformer* will not result in a *loss of demand* within the C4 *demand group* unless the remaining *transformer* is unable to *supply* the total C4 demand.

In relation to whether the above scenarios are compliant with the planning criteria.

- The requirements related to Rural demand groups also apply as per Table 2-11:
- In relation to scenario 1, the same comments and limitations noted for the C3 *demand group* also apply to the C4 *demand group* i.e. the restoration requirements in relation to 66 kV overhead line outages varies depending on the total C4 *group demand* and whether this less than or greater than 20 MVA.
- Under scenario 2, the loss of a *zone substation transformer* will not result in a *loss of demand* as long as the C4 *group demand* is supplied in full.

  If the full C4 *group demand* cannot be supplied on one *zone substation transformer*:

  - If the C4 *group demand* is <10 MVA then it is permissible for demand to be lost for the duration of "Repair Time".

- If the C4 *group demand* is ≥ 10 MVA and < 60 MVA then it is permissible for demand to be lost for the duration of "remote switching". However, if as in this example, there is no neighbouring *substation* to transfer the demand to then operating the C4 *zone substation* such that the full *load* cannot be supplied on a single *transformer* would not be compliant with the planning criteria.

A15.4 *Group demand* example 4

This example considers *Demand Group* B2 which is within wider *Demand Group* A1 shown in Figure A15-1.

Consider the following characteristics for *Demand Group* B2:

- The *demand group* is supplied by two bus-tie 132 / 66 kV *transformers* each rated at 90 MVA,
- Both bus-tie *transformers* are supplied from the same 132 kV *busbar*, with each *transformer connected* to a separate 66 kV *busbar* which are operated closed i.e. in parallel.
- The total demand includes *Demand Group* C3 and C4 at 25 MVA each plus a 35 MVA customer *load* supplied from the 66 kV *busbar* at the terminal *substation* via a single circuit (not shown).
- There is no *transfer capacity* from other substations.

The *security* of *supply* of the demand within *Demand Group* B2 can be summarised by the following scenarios.

1. The *outage* of a bus-tie *transformer* will not result in any *loss of demand* to the 66 kV network, as the total demand can be supplied through the remaining bus-tie *transformer*.
2. The *outage* of the 132 kV *busbar* to which the bus-tie *transformers* are *connected* will result in the loss of the full *demand group*, until:
   - The *outage* of the 132 kV *busbar* is restored, with the *busbar* plant and equipment being repaired / replaced as necessary,
   - The bus-tie *transformers* are switched to an alternative 132 kV *busbar* section unaffected by the first *outage* – depending on the *substation* configuration, this may be achieved automatically or through remote switching actions.
3. The loss of one section of 66 kV *busbar*, and hence one bus-tie *transformer*, will result in the *loss of demand* to the downstream *demand group*(s) if:
   - the remaining bus-tie *transformer* cannot *supply* the full downstream combined demand,
   - the remaining 66 kV overhead lines cannot *supply* the individual downstream demand.

   this will be the case until:

   - the 66 kV *busbar* fault is addressed,
   - the affected 132 / 66 kV bus-tie *transformer connected* to the faulted 66 kV *busbar* section is transferred to the healthy 66 kV *busbar* section; or
   - the affected outgoing 66 kV *transmission* circuits, *connected* to the faulted 66 kV *busbar* section, are transferred to the healthy 66 kV *busbar* section.

Reviewing the requirements of Table 2-11, the following conclusions can be made with regards to whether the above scenarios are compliant with the planning criteria.

- The requirements related to Rural demand groups apply as per Table 2-11.
- In relation to scenario 1, if the total demand in *Demand Group* B2 is <85 MVA as stated in the example, then the requirements for the ≥ 20 MVA & < 90 MVA *Demand Group* (no *loss of demand*) should be met, which are in this case.
- Note that as per the definitions that follow Table 2-11, the *outage* of a bus-tie *transformer* is considered within the TCT, *Transmission* Circuit contingency category.
- Further in relation to scenario 1, if the total demand exceeded 90 MVA then the loss of a bus-tie *transformer* would not satisfy the outlined requirements. Even though the customer *connected* at 66 kV has agreed to single circuit risk, unless otherwise agreed, this would normally only apply to their dedicated connection circuit. As a result, the full *Demand Group* B2 *load* will still need to be secured (no *loss of demand*) following the *outage* of a bus-tie *transformer*.
- With respect to scenario 2, the ≥ 20 MVA & < 90 MVA *Demand Group*, as defined in Table 2-11, does not include *busbars* within the *credible contingency* category, whether 66 kV or 132 kV. As a result, under the stated example with total demand within *Demand Group* B2 of 85 MVA, there is no requirement to design the *transmission* network to recover this demand following a contingency involving 66 kV or 132 kV *busbars*.

  However, if the total demand in *Demand Group* B2 was to exceed 90 MVA, then a *busbar outage*, at 66 kV or 132 kV, is considered a *credible contingency* and hence the *demand group* would have to be designed to comply with the requirements of the ≥ 90 MVA & < 250 MVA *demand group* as per Table 2-11.

  Taking the outlined Example 4, if the bus-tie *transformers* were rated at 120 MVA (instead of 90 MVA) and the total Group B2 demand is > 90 MVA, then a *credible contingency* involving a 66 kV *busbar* will not meet the requirements of Table 2-11 unless:

  - the *outage* of the *busbar* would not lead to any demand loss within demand groups C3 and C4, or
  - the 66 kV *busbars* are configured in a double *busbar* (or alternative) configuration to avoid an *outage* of the outgoing 66 kV *transmission* circuits or bus-tie *transformer* during a 66 kV *busbar* fault.
- Finally, in relation to scenario 2, if the total B2 *group demand* > 90 MVA then a contingency involving a 132 kV *busbar* fault at the terminal *substation* will also not be able to meet the requirements of Table 2-11, unless the bus-tie *transformers* are supplied from different 132 kV *busbar* sections such that an *outage* of one 132 kV *busbar* section can be isolated without disconnecting the other *busbar* section. This will be the case even if a single bus-tie *transformer* is able to *supply* the total B2 *group demand*.
- In summary, for *Demand Group* B2 whether this group can meet the planning criteria requirements will depend on:
  - The total value of the B2 *group demand* i.e. whether greater than or less than 90 MVA,
  - How the 132 kV and 66 kV *busbars* at the terminal *substation* connecting the bus-tie *transformers* are configured,

- The rating of the bus-tie *transformers*, and whether these can *supply* the total B2 *group demand*,
- The rating of the outgoing 66 kV overhead lines supplying the downstream *zone substations* – depending on the 66 kV *busbar* configuration.

For the B2 *demand group* to meet the planning criteria all applicable contingency elements i.e. *transmission* circuit, bus-tie *transformers*, *busbar*s, must all meet the applicable requirements otherwise the *demand group* will not meet the planning criteria.

7. *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