DRAFT TECHNICAL RULES

Western Power Corporation
Strategy and Corporate Affairs Division

363-365 Wellington Street
Perth Western Australia 6000
GPO Box L921 Perth WA 6001

Draft dated 11 April 2006

IMPORTANT NOTE: This document is subject to amendment (amendments must be made in accordance with the *Electricity Networks Access Code 2004*). People referring to this document are advised to consult the General Manager Strategy and Corporate Affairs Division, Western Power Corporation, to ensure that they have the latest version. The document is available for downloading at Western Power's internet site: http://www.westernpower.com.au

This page has been left blank intentionally.

PREFACE

Chapter 12 of the *Electricity Networks Access Code 2004* (WA) (the "*Access Code*") requires Western Power to publish Technical *Rules* (the "*Rules*"). In addition, Appendix A6.1(m) of the Access Code requires Western Power to publish *transmission system planning criteria*.

These *Rules* cover the portions of the *South West Interconnected System* ("*SWIS*") owned and operated by Western Power, and detail the technical requirements to be met by Western Power on the *transmission and distribution systems* and by *Users* who connect *facilities* to the *transmission and distribution systems*. In addition, the planning criteria to be applied to the *transmission and distribution systems* are contained within these *Rules*. Prospective *Users* or existing *Users* who wish to connect *facilities* to the *transmission and distribution systems* must first submit an *access application* to Western Power in accordance with the *Access Code*.

As this document is subject to amendment, people referring to this document are advised to consult the General Manager, Strategy and Corporate Affairs Division, Western Power Corporation, at the address below, to ensure that they have the latest version.

General Manager Strategy and Corporate Affairs Division
Western Power Corporation
GPO Box L921
PERTH WA 6001

Telephone: (08) 9326 6687

Facsimile: (08) 9326 6550

The document can also be examined and downloaded at Western Power's internet site: http://www.westernpower.com.au

This document is the draft technical rules, pursuant to section 12.11(c) of the Access Code. The draft technical rules have been amended by the Economic Regulation Authority to the extent necessary for Western Power's proposed technical rules to comply with chapter 12 of the Access Code and the Code objective in section 2.1 of the Access Code.

It is important to note that amendments to this document, and variations and exemptions to *Rules* requirements granted to *Users*, can only be made in accordance with the *Access Code*.

This page has been left blank intentionally.

-

DRAFT TECHNICAL *RULES*

TABLE OF CONTENTS

TABLE OF CONTENTS

1. GENERAL

1.1 INTRODUCTION

(a) This section 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 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 set out:

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

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

(c) the requirements for the operation of the *transmission and distribution systems* (including the operation of the *transmission and distribution 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* acting in accordance with the Wholesale Electricity Market 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 apply if the *Network Service Provider* believes that a *User's equipment* does not comply with the requirements of these *Rules*;

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

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

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

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

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

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

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

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

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

(o) the *transmission and distribution systems* planning criteria as required by section A6.1(m) of the *Access Code*.

1.3 APPLICATION

(a) In these *Rules*, unless otherwise stated, a reference to the *Network Service Provider* refers to the Networks Business Unit of Western Power for the *South West Interconnected System*, or its successor organisations, but 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*;

(2) *System Management* in its role as *operator* of *the power system*;

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

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

(B) every person to whom access to *transmission* and *distribution* capacity is made available (including every

person with whom the *Network Service Provider* has entered into an *access contract*); and

(4) the Arbitrator, as defined in the *Access Code*.

(c) These *Rules* apply to all:

(1) *equipment* and *facilities* forming part of the *transmission and distribution systems*; and

(2) *connection assets*.

1.4 COMMENCEMENT

These *Rules* come into operation on **dd *Month* 2006** (the "*Rules commencement date*").

1.5 INTERPRETATION

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

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

1.6 THE *NETWORK SERVICE PROVIDER* AND *USERS* TO ACT REASONABLY

1.6.1 Importance of objectives

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

1.6.2 Acting reasonably

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

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

1.7 DISPUTE RESOLUTION

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

1.8 OBLIGATIONS

1.8.1 General

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

(1) relevant laws;

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

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

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

(b) Where an obligation is imposed under these *Rules* to arrange or control any act, matter or thing or to 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* 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* or *User* is not taken to have breached such obligation imposed under these *Rules* provided the *Network Service Provider, System Management* 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 performance standards:

(1) described in these *Rules*; and

(2) prescribed in any *access contract* with a *User*.

(b) The *Network Service Provider* must:

(1) ensure that, for *connection points* on the *transmission and distribution 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 undertake tests, or require *Users* to undertake tests in accordance with clause 4.1, where there are grounds to question the validity of data.

(c) The Network Service Provider must arrange for:

(1) management, maintenance and operation of the *transmission and distribution systems* such that when the *power system* is in the *normal operating state* electricity may be transferred continuously at a *connection point* up to the *agreed capability* of that *connection point*;

(2) 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

(3) 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*.

1.9 VARIATIONS AND *EXEMPTIONS* FROM THE RULES

1.9.1 *User* Exemptions from these *Rules*

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

(b) 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*.

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

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*

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

1.9.4 *Transmission and Distribution Systems* and *Facilities* Existing at DD Month 2006

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 an *access contract* or projects of the *Network Service Provider* for which work has commenced prior to the *Rules commencement date*.

1.9.5 *Ongoing Suitability*

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 monitored on an ongoing basis and must ensure its continued safety and suitability as conditions on the *power system* change.

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

2.1 INTRODUCTION

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

2.2 POWER SYSTEM PERFORMANCE STANDARDS

2.2.1 *Frequency* Variations

(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* for the *power system* are summarised in Table 2.1.

Table 2.1 *Frequency* Operating Standards for *SWIS*.

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

Condition	*Frequency* Band	Target Recovery Time
		minutes (c) above 48.5 Hz within 15 minutes. (d) For over-*frequency* events: (e) below 51.5 Hz within 1 minute (f) below 51.0 Hz within 2 minutes (g) 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 south-west and the Goldfields is broken.

(d) *Frequency* tolerance limits must be satisfied, provided that there is no shortage of spinning reserve in accordance with clause 3.10.2 of the Wholesale Electricity 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* tolerance limits 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 that the *frequency* recovers to the normal *voltage* range within the time frames prescribed in Table 2.1 following a multiple contingency event.

2.2.2 Steady State Power *Frequency Voltage*

(a) Except as a consequence of a 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 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 the nominal *voltage* during *normal operating state*,

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

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

(b) Step *change*s in 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

Cause	**Pre-*tap-changing* *(quasi steady-state)***		**Post-*tap-changing* (final steady state)**	
	≥ 66 kV	< 66 kV	≥ 66 kV	< 66 kV
Routine Switching(1)	±.4.0% (max)	±.4.0% (max)	*Transmission voltages* must be between 110% and 90% of nominal *voltage*	Must attain previous set point
Infrequent Switching or Events(2)	+6%, –10% (max)	+6%, –10% (max)	*Transmission voltages* must be between 110% and 90% of nominal *voltage*	Must attain previous set point

Notes:
1. For example, capacitor switching, *transformer* tap action, motor starting, start-up and shutdown of *generating units*.
2. For example, tripping of *generating units*, *loads*, lines and other components, typically as a result of faults.

(c) Where more precise control of voltage is required than is provided for under clause 2.2.2(a), a target range of *voltage* magnitude at a *connection point*, may be agreed with a *User* and specified in an *access contract*. This may include different target ranges under normal and post-contingency conditions (and how these may vary with *load*). Where 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 an *access contract, Users* should allow for short-time variations within 5% of the target values in the design of their equipment.

2.2.3 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 2.3 for 99% of the time.

Table 2.3 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 is unity. The planning levels could be increased in accordance with AS61000.3.7 (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.

2.2.4 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 (as applicable) appropriate to the *voltage* level.

Table 2.4 *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

Odd harmonics non multiple of 3		**Odd harmonics multiple of 3**		**Even harmonics**	
17	1.6	>21	0.2	10	0.4
19	1.2			12	0.2
23	1.2			>12	0.2
25	1.2				
>25	$0.2 + 0.5\frac{25}{h}$				
Total harmonic distortion (THD): 6.5 %					

Table 2.5 *Transmission* planning levels for harmonic *voltage* in networks with system *voltage* above 35 kV (in percent of the nominal *voltage*)

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

Notes:

1. The planning levels in Table 2.4 and Table 2.5 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:

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

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 and Table 2.5 are consistent with *AS* 61000 (1998).

2.2.5 Negative Phase Sequence *Voltage*

The 30 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 2.6 Limits for negative phase sequence component of *voltage* (in percent of the positive phase sequence component)

Nominal System *Voltage* (kV)	**Negative Sequence *Voltage* (%)**
> 100	1
10 – 100	1.5
< 10	2

2.2.6 Electromagnetic Interference

Electromagnetic interference caused by *equipment* forming part of the *transmission and distribution system* must not exceed the limits set out in Tables 1 and 2 of *Australian Standard* AS2344 (1997).

2.2.7 Transient Rotor Angle Stability

All *generating units* connected to the *transmission system* and *generating units* within *power stations* that are connected to the *distribution system* and that have a total rated output of 10 MW or more must remain in *synchronism* following a *credible contingency event*.

2.2.8 Oscillatory Rotor Angle Stability

System oscillations originating from system electro-mechanical characteristics, electro-magnetic effect or non-linearity of system components, and triggered by any *small disturbance* or *large disturbance* in 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:

(a) The *damping ratio* of electromechanical oscillations must 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.

(c) In addition to the requirements of clauses 2.2.8(a) and 2.2.8(b), the *halving time* of any electro-mechanical oscillations must not exceed 5 seconds.

2.2.9 Short Term *Voltage Stability*

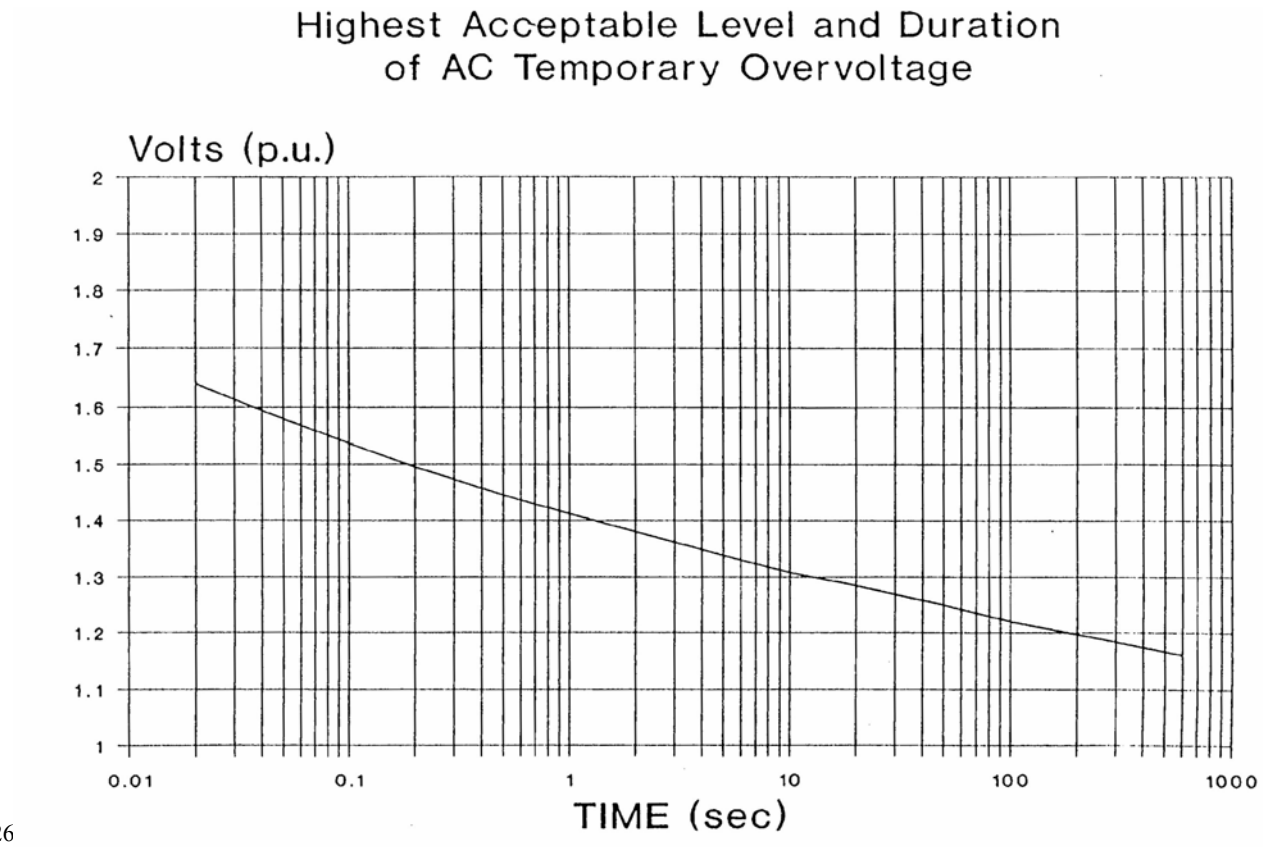
(a) Short term *voltage stability* is concerned with the *power system* surviving an initial disturbance and reaching a satisfactory new steady state.

(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 2.2.

Figure 2.2 - Highest Acceptable Level and Duration of AC Temporary Over-*Voltage*



Notes:
1. In Figure 2.2 the 1 per unit (p.u.) 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 2.2.2(c).
2. For the purposes of clause 2.2.10, the voltage is the RMS 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 event specified in clauses 2.3.7.1(a) and 2.3.7.2 under all credible *load* conditions and *generation* patterns.

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 underfrequency *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 underfrequency *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 underfrequency or undervoltage *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 *access contract*.

2.3.2 *Load* to be Available for *Disconnection*

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 underfrequency relays;

(2) manual or automatic control from *control centre*s; 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.

2.3.3 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 2.2.3, the *Network Service Provider* must, where necessary and after consultation with the relevant *Users,* allocate flicker emission limits to *Users* in accordance with clauses 2.3.3(b) and 2.3.3(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*/ANZ 61000.3.7 (2001).

(c) If the *User* cannot meet the contribution calculated by using the method of clause 2.2.3(b), then the *Network Service Provider* may use, in consultation with the party seeking *connection,* the stage 3 evaluation procedure defined in *AS*/ANZ 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 (2001).

2.3.4 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, 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* and the *power system*.

(c) The measurement must be carried out according to *AS*/NZS 61000.4.7 (2001). Harmonics must generally be measured up to h=40. However, higher order harmonics up to 100^{th} order may be measured if the *Network Service Provider* reasonably considers them to be of material concern.

2.3.5 Negative Phase Sequence *Voltage*

If the maximum level of negative phase sequence voltage, as specified in Table 2.6, 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*.

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

2.3.6 Electromagnetic Interference

The *Network Service Provider* must respond to all complaints regarding electromagnetic interference in a timely manner and undertake any necessary tests to determine whether or not the interference is caused by *equipment* forming part of the *transmission and distribution system*s, and whether or not it exceeds the limits specified in clause 2.2.6. 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.

2.3.7 Power System Stability and Dynamic Performance

2.3.7.1 Short Term Stability

(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 2.2.7 to 2.2.10 are met under the worst credible system *load* and *generation* patterns, and the most critical, for

the particular location, of the following *credible contingency events* without exceeding the rating of any *power system* component or, where applicable, the allocated *power transfer* capacity:

(1) a three-phase to earth fault cleared by *disconnection* of the faulted component, with the fastest main protection out of service;

(2) a single-phase to earth fault cleared by the *disconnection* of the faulted component, with the fastest main protection out of service;

(3) a single-phase to earth fault cleared after unsuccessful high-speed single-phase auto-reclosure onto a persistent fault;

(4) a single-phase to earth fault cleared by the backup protection; or

(5) sudden *disconnection* of a system component, e.g. a *transmission line* or a *generation* unit.

(b) To ensure compliance with clause 2.3.7.1(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.

(c) 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 *main protection schemes*, where *duplicate main protection schemes* exist. Where there is only one *primary* protection scheme, the *backup protection fault clearance time* must be used for simulations.

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 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 backup, 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 *transformer*s.

2.3.7.4 Validation of Modelling Results

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 3 are valid. This may include *power system* and plant performance tests in accordance with clause 4.1.

2.3.8 Determination of Power Transfer Limits

(a) The *Network Service Provider* must assign, on a request by a *User* or *System Management*, *power transfer* limits to *equipment* forming part of the *transmission and distribution systems*. 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 vary in accordance with different *power system* operating conditions.

(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.

2.3.9 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 2.2 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 2.2.5 are taken as specified in Table 2.7. 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* on request.

Table 2.7 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 System*

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

2.5 *TRANSMISSION AND DISTRIBUTION SYSTEM* PLANNING CRITERIA

2.5.1 Application

The 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 criteria described below:

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 to the 220 kV *interconnection* supplying the Eastern Goldfields region.

In the event of an unplanned outage of the 220 kV *interconnection* supplying the Eastern Goldfields region the *power system* is expected to split into two islands with the load in each island capable of being supplied by local *generation.* The *network service provider* must ensure that sufficient local *generation* is available to supply residential *loads* in Kalgoorlie city. Other *Users* will need to make their own arrangements for the provision of any required backup *generation*.

(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 backup *power transfer* capacity is available, *load shedding* is permissible. Where a supply loss 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 backup *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.

(b) For sub-networks designed to the N-1 criterion (excluding a *zone substation* designed to the 1% risk or NCR criteria in accordance with clause 2.5.3.2), *supply* must be maintained and *load shedding* avoided at any *load* level and for any *generation* schedule following an outage of any single *transmission element*.

(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) 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 transformer*s 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

(a) The N-1-1 Criterion applies to those sub-networks of the *transmission system* where the occurrence of a *credible contingency* during planned maintenance of another *transmission element* would otherwise result in the loss of *supply* to a large number of *Consumers*. Sub-networks of the *transmission system* that are designed to the N-1-1 criterion include:

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

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

(3) all 132 kV *transmission lines* that *supply* a sub-system of the *transmission system* comprising more than 5 *zone substations* with total *peak load* exceeding 400 MVA; and

(4) all power stations whose total rated export to the *transmission system* exceeds 600 MW.

(b) The range of operating conditions that are allowed for when planning a part of the *transmission system* to meet the N-1-1 criterion is set out in Table 2.9.

Table 2.9 Transmission System Operating Conditions Allowed for by the N-1-1 Criterion

Maintenance *Outage*s 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*

(c) Under the N-1-1 criterion, each sub-network must be capable of withstanding the coincident planned and unplanned *outage*s of *transmission element*s listed in

Table 2.9 at up to 80% of the expected *transmission system peak load*. In determining whether the N-1-1 criteria has been met, the *Network Service Provider* may assume that, during the planned *outage*, *generation* has been rescheduled to mitigate the effect of the subsequent unplanned *outage*.

(d) Following the unplanned *outage* of the *transmission element*, the *power system* must continue to operate in accordance with the performance standards specified in clause 2.2, provided the *transmission system load* remains below 80% of the expected *peak load*.

2.5.2.4 *Circuit Breaker Failure*

If a *circuit breaker failure* occurs and, as a resut, 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 Central Business District Criterion

(a) The Perth Central Business District (CBD) criterion applies to those sub-networks of the *transmission system* that transfer power to the *Perth CBD Zone* and it currently applies to the Milligan Street and Hay Street *zone substations* and the *transmission* lines that terminate in those *zone substations*. This coverage may be extended in the future as the Perth CBD grows.

(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 Zone* 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 t*o 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.

2.5.3.2 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 the loss of a portion of *power transfer* capacity at a *substation* following the unplanned loss of a *supply transformer* within that *substation*.

(2) The portion of the *power transfer* capacity that may be lost is the lesser of:

(A) 75% of the *power transfer* capacity of the smallest *supply transformer* within the *substation*; and

(B) 90% of the *power transfer* capacity of the rapid response spare *supply transformer*.

Explanatory note: Relationship between 1% Risk criterion and NCR criterion.

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 transformer*s 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.

2.5.3.3 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.

2.5.3.4 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 *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*.

(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.

2.5.4 *High Voltage Distribution System*

2.5.4.1 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 *access contract*. 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*.

2.5.4.2 Distribution Feeders in the Perth CBD Zone

Distribution feeders in the *Perth CBD Zone* 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.

2.5.4.3 Urban *Distribution Feeders*

(a) Existing Urban *Distribution Feeders*

Urban distribution feeders in existence at the *Rules commencement date* must be designed so that, in the event of a 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.

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

(b) Urban *Distribution Feeders* Constructed After the *Rules Commencement Date*

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

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

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

(B) the 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 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*.

2.5.4.4 Radial Distribution Feeder Loads in the Perth Metropolitan Area

For all *distribution feeders* within the Perth metropolitan area, the *Network Service Provider* must limit the number of domestic customers in a switchable feeder section to 860, if the switchable feeder section is not able to be energised through a backup normally open interconnection.

2.5.4.5 Rural *Distribution Feeders*

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

2.5.5 *Low Voltage Distribution System*

(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 *Consumers*.

2.5.6 Pole to Pillar *Connections* Mandatory

All new *Consumer connections* and upgrades to existing overhead services due to capacity increases, must be underground, even if the service mains are to be connected to an overhead *distribution line*.

2.5.7 *Distribution* Remote Control and Monitoring

(a) All new and replacement switches (including ring main units) must be capable of being remotely operable.Switches in key network positions will need to be controlled from the *distribution system control centre. All switches are to* be fitted with fault passage indication; and

(b) All new and replacement *distribution transformer*s must be fitted with load monitoring facilities which are capable of being modified for monitoring from the *distribution system control centre*.

2.5.8 Fault Limits

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.

2.5.9 Maximum *Distribution System* Fault Currents

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

(1)	415 V networks	50 kA
(2)	6.6 kV networks	21.9 kA
(3)	11 kV networks	25 kA
(4)	22 kV networks	16 kA
(5)	33 kV networks	13.1 kA

(b) Equipment may be installed with a lower fault *current rating* in accordance with the *WA Electrical Requirements* where the fault level is unlikely to exceed the lower rating for *credible contingency events.*

2.6 *SUBDIVISION* DESIGN CRITERIA

(a) All residential commercial and industrial subdivision *distribution systems* must be designed to *supply* the maximum reasonably foreseeable *load* anticipated for that subdivision. The maximum reasonably foreseeable *load* for the subdivision shall be agreed by the *Network Services Provider* and the developer and must be determined by estimating the *peak load* of the subdivision after it has been fully developed, assuming the current electricity consumption patterns..

(b) The *Network Service Provider* may require developers to provide *distribution systems* in residential commercial and industrial subdivisions that are designed to minimises the cost of providing additional distribution system capacity should electricity consumption patterns change.

(c) The *Network Service Provider* may require a developer to provide ducts for *high voltage distribution system* cables to supply future neighbouring subdivisions but must not require developers to provide *high voltage distribution system* cables if these are not required to supply the developer's own subdivision.

2.7 *TRANSMISSION AND DISTRIBUTION SYSTEM* DESIGN AND CONSTRUCTION STANDARDS

The *Network Service Provider* must ensure that the *transmission and distribution system* comply with relevant codes standards and regulations, including the *Access Code*; the "Guidelines for Electricity Transmission and Distribution Work in Western Australia" issued by Energy Safety and relevant ESAA Guides, Australian and International Electricity Commission (IEC) Standards, the *Network Service Provider's* fire-proofing requirements and any relevant requirements of the *WA Electrical Requirements*.

2.8 *DISTRIBUTION* CONDUCTOR OR CABLE SELECTION

*Extension*s 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 time cost to the community; and

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

2.9 *TRANSMISSION AND DISTRIBUTION SYSTEM PROTECTION*

2.9.1 General Requirements

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

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

(c) Protection schemes 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 transformer*s and *voltage transformers* comply with *AS* 60044 (2003).

2.9.2 Duplication of *Protection*

(a) ***Transmission system***

(1) *Equipment* operating at *transmission system voltages* must be protected by a *main protection system* that must remove from service only that item of *primary equipment* directly affected by the fault. For *primary equipment* operating at a nominal *voltage* of 66 kV or higher, the main *protection system* must include duplicate *main protection schemes,* each of which must be fully independent and of *differing principle*. One of the independent *protection schemes* must include earth fault *protection*. For *primary equipment* operating at a nominal *voltage* of less than 66 kV, the *main protection scheme* does not need to be duplicated, but the *equipment* must be protected by two

fully independent *protection schemes* one of which may be a remote *backup protection scheme*.

(2) *Primary equipment* operating at the *transmission system voltages* must also be protected by a *backup protection system* in addition to the *main protection system*. The *backup protection system* must isolate the faulted *primary equipment* if a main *protection* fails to operate, or a *small zone* fault occurs, or a *breaker failure* condition occurs. *For primary equipment* operating at nominal voltages of 220 kV and above the *backup protection system* must comprise *two fully independent protection schemes of differing principle* that must discriminate with other *protection schemes*. *Primary equipment* operating at nominal voltages of less than 220kV must be protected by a single *backup protection scheme, except that small zone faults* must be included in the operating zone of two independent *backup protection schemes.*

(3) A duplicate *protection scheme* must incorporate full redundancy of *secondary equipment* so that a failure of one *protection scheme* to operate as a result of *a secondary equipment* fault will not prevent the second *protection scheme* from operating as designed.

(4) The design of a duplicate *protection scheme* must make it possible to test and maintain either protection without interfering with the other.

(b) ***Distribution system***

(1) Each item of *primary equipment* forming part of the distribution system must be protected by two fully independent *protection schemes*. One of the independent *protection schemes* must be a *main protection scheme* that must remove from service only the faulted item of *primary equipment.* The other independent *protection scheme* may be a remote *backup protection scheme*.

(2) Notwithstanding the requirements of clause 2.9.2(b)(1), duplicate *main protection schemes* complying with the requirements of clause 2.9.2(a) must be provided where a part of the *distribution system* may potentially form a separate island.

2.9.3 Availability of Protection Systems

(a) All *protection schemes*, including any *backup* 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 either of the *protection schemes* forming part of the duplicate *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*.

(c) Should either 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*.

2.9.4 Maximum *Total Fault Clearance Times*

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

(b) For *primary equipment* operating at a nominal *voltage* of 220 kV and above, both *main protection schemes* of a duplicate *protection system* must achieve a *total fault clearance time* no greater than the "No CB Fail" time given in Table 2.11. Both *backup protection schemes* must achieve a *total fault clearance* time no greater than the "CB Fail" time given in Table 2.11.

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

(1) one of the *main protection schemes* must achieve a *total fault clearance time* no greater than the "No CB Fail" time given in Table 2.11. The other *main protection scheme* must achieve a *total fault clearance time* no greater than the "No CB Fail" time in Table 2.12. The *backup protection scheme* must achieve a *total fault clearance time* no greater than the "CB Fail" time in Table 2.11. For *small zone faults* the second *backup protection scheme* must achieve a *total fault clearance time* no greater than 400 msec;

(2) on 132 kV lines longer than 40 km, all *main* and *backup protection schemes* must achieve the relevant maximum *total fault clearance time* given in Table 2.12; and

(3) on 66 kV lines longer than 40 km, one *main protection scheme* must achieve the *total fault clearance times* specified for 132 kV in Table 2.12 (rather than the times specified in Table 2.11). The other *protection scheme* must achieve the maximum *total fault clearance times* specified for 66 kV in Table 2.12.

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

(e) In Table 2.11 and Table 2.12, the term "local end" refers to a fault on:

(1) *Primary equipment* located within a substation;

(2) Primary *connection assets*; or

(3) 50% of the *transmission* or *distribution* line nearest to the *protection system* (in which case "remote end" refers to the remainder of the line).

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

Table 2.11 Maximum *Total Fault Clearance Times* (msec).

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

Table 2.12 Alternate Maximum *Total Fault Clearance Times* (msec) for 132 kV and 66 kV lines.

		Existing *Equipment* No CB Fail	**Existing *Equipment* CB Fail**	**New *Equipment* No CB Fail**	**New *Equipment* CB Fail**
132 kV	Local end	150	400	115	310
	Remote end	400	650	400	565
66 kV	Local end	1000	Not defined	115	310
	Remote end	Not defined	Not defined	400	565

2.9.5 Critical Fault Clearance Times

(a) Notwithstanding the requirements of clause 2.9.4, where necessary to ensure that the *power system* complies with the performance standards specified in clause 2.2, the *Network Service Provider* may designate a part of the *transmission or distribution system* as subject to a *critical fault clearance time*. The *critical fault clearance time* may be lower than the standard maximum fault clearance time set out in Table 2.11. The network configurations to which the *critical fault clearance time* applies shall be specified by the *Network Service Provider*.

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

2.9.6 Protection Sensitivity

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

(b) For *minimum and maximum system conditions,* all *protection schemes* must discriminate and clear 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 and cleared by at least one

protection. *Backup protections* may be relied on for this purpose. *Fault clearance times* are not defined under *abnormal equipment conditions*.

2.9.7 Trip Supply Supervision Requirements

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

2.9.8 Trip Circuit Supervision Requirements

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

2.9.9 Protection Flagging and Indication

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

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

3. TECHNICAL REQUIREMENTS OF *USER FACILITIES*

3.1 INTRODUCTION

(a) This section 3 sets out details of the technical requirements which *Users* must satisfy as a condition of *connection* of any *equipment* to the *transmission and distribution systems* (including *embedded generating units*), 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) The objectives of this section 3 are to facilitate maintenance of the *power system* performance standards specified in section 2.2, so that other *Users* are not adversely affected and that personnel and equipment safety are not put at risk following, or as a result of, the *connection* of a *User's equipment*.

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 Wholesale Electricity Market Rules or under a commercial arrangement with the *Network Services Provider*. *Users* who provide these *ancillary services* may be required to comply with technical requirements over and above those specified in this section 3. These additional requirements will be specified in the relevant *ancillary services* contract.

3.2 REQUIREMENTS FOR ALL *USERS*

3.2.1 *Power System* Performance Standards

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

(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 2.3.3.

(c) **Harmonics**

(1) A *User* must ensure that the injection of harmonics or interharmonics from its *equipment* or *facilities* into the *transmission or distribution systems* is below the maximum system levels set out in Table 2.4 and Table 2.5.

(2) A *User* must not inject into the *transmission or distribution system* any DC component of current or *voltage* produced by its own *equipment.*

(d) **Negative Phase Sequence Voltage**

A *User* connected to all three phases must balance the current drawn in each

phase at its *connection point* so as to achieve 30-minute average levels of negative sequence *voltage* at all *connection points* that are equal to or less than the values set out in Table 2.6.

(e) **Electromagnetic Interference**

A *User* must ensure that the electromagnetic interference caused by the *equipment* at its *connection point* does not exceed the limits set out in Tables 1 and 2 of *Australian Standard* AS2344 (1997).

(f) **Fault Levels**

Notwithstanding the provisions of clause 2.5.9(b), a *User* may not install or connect *equipment* on or to the *distribution system* that is rated at a level lower than that permitted by clause 2.5.9(a) without an appropriate *exemption* from these *Rules*.

Where a *User's equipment* increases the fault levels in the *transmission system* or *distribution 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*.

3.2.2 Main Switch

Except as provided in clause 3.3.4.10, 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*

(a) The *Network Service Provider* may require a *User* to provide accommodation and connections for the *Network Service Provider's* power quality monitoring and recording *equipment* within the *User's facilities* or at the *connection point*. In such an event the *User* must meet the requirements of the *Network Service Provider* in respect of the installation of the *equipment* and shall provide access for reading, operating and maintaining this *equipment*.

(b) 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*

(a) A *User* must provide to the *Network Service Provider* such of the following information relating to any of the *User's 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 set of functional block diagrams, including all transfer functions between feedback signals and *generating unit* output;

(2) the parameters of each functional block, including all settings, gains, time constraints, delays, deadbands 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 system* for the purposes of enabling that *User* to undertake any *power system* simulation studies it wishes to undertake, subject to that *User* or 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.

3.3 REQUIREMENTS FOR *CONNECTION* OF GENERATORS

3.3.1 General

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

(b) A *Generator* must operate *facilities* and *equipment* in accordance with any and all *direction*s given by *System Management* 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 WA wholesale market. Wholesale market participation is compulsory for *generation equipment* rated 10 MW and above.

(d) A *generating unit* must have *equipment* characteristics and *control system*s, 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 stability*;

(2) reduced *frequency stability*; or

(3) reduced *voltage stability*,

relative to the level that would apply if the *generating unit* were not *connected*.

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,* the *power transfer capability* of the *power system* will be reduced.

(e) 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*.

The effect of this clause is to limit the maximum *generating unit* size that is permitted to connect to the *transmission or distribution system*.

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

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

(h) A *generating unit* must *disconnect* from the *distribution system* if the *distribution feeder* to which it is *connected* is separated from the remainder of the *power system*.

3.3.2 Technical Matters to be Coordinated

A *Generator* 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.

3.3.3 Provision of Information

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

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

3.3.4 Detailed Technical Requirements Requiring Ongoing Verification

A *Generator* must verify compliance of its own *equipment* with the technical requirements of this clause 3.3.4 by the methods described in clause 4.1.3.

3.3.4.1 *Reactive power capability*

(a) Each *generating unit*, and the *power station* in which the *generating unit* is located, must be capable of continuously providing its full *reactive power* output within the full range of steady state *voltages* at the *connection point* permitted under clause 2.2.2.

A *generating unit transformer*'s tapping range may be used to achieve this capability.

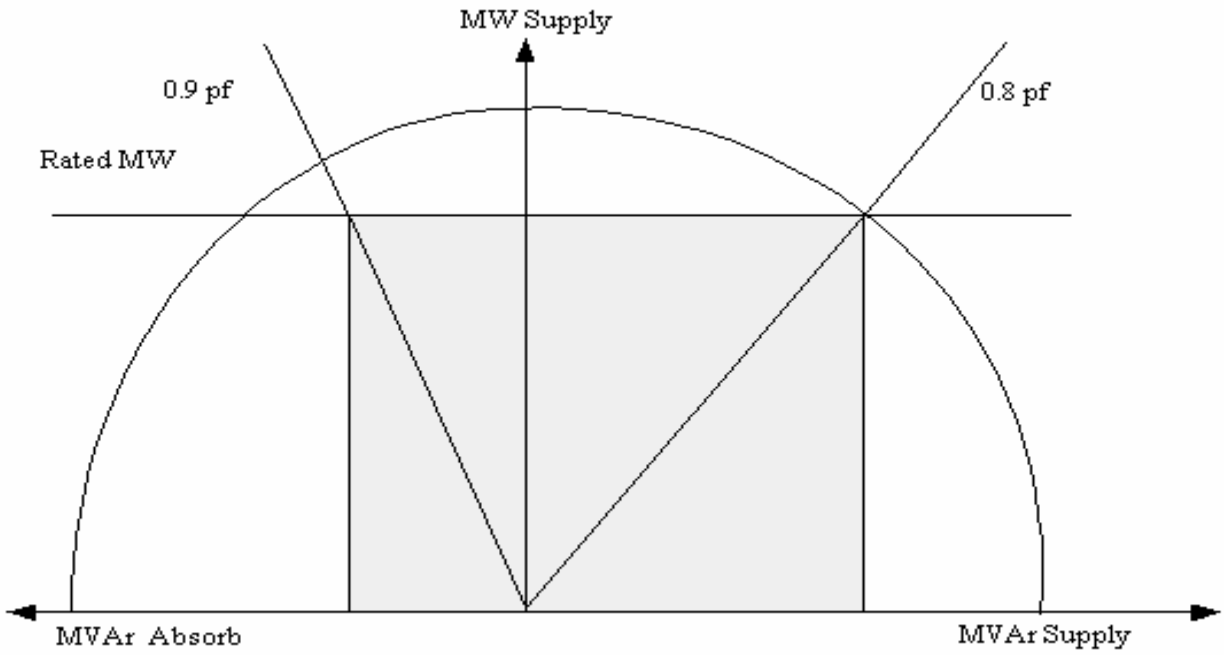
(b) (1) Each synchronous generating unit, while operating at any level of power output, must be capable of:

(A) supplying at its *generator machine's* terminals an amount of *reactive power* that at the rated active power output of the generating unit at nominal voltage would result in a *power factor* of less than or equal to 0.8; and

(B) absorbing at its generator machine's terminals an amount of reactive power that at the rated active power output of the generating unit at nominal voltage would result in a power factor is less than or equal to 0.9.

Refer to Figure 3.1 for details.

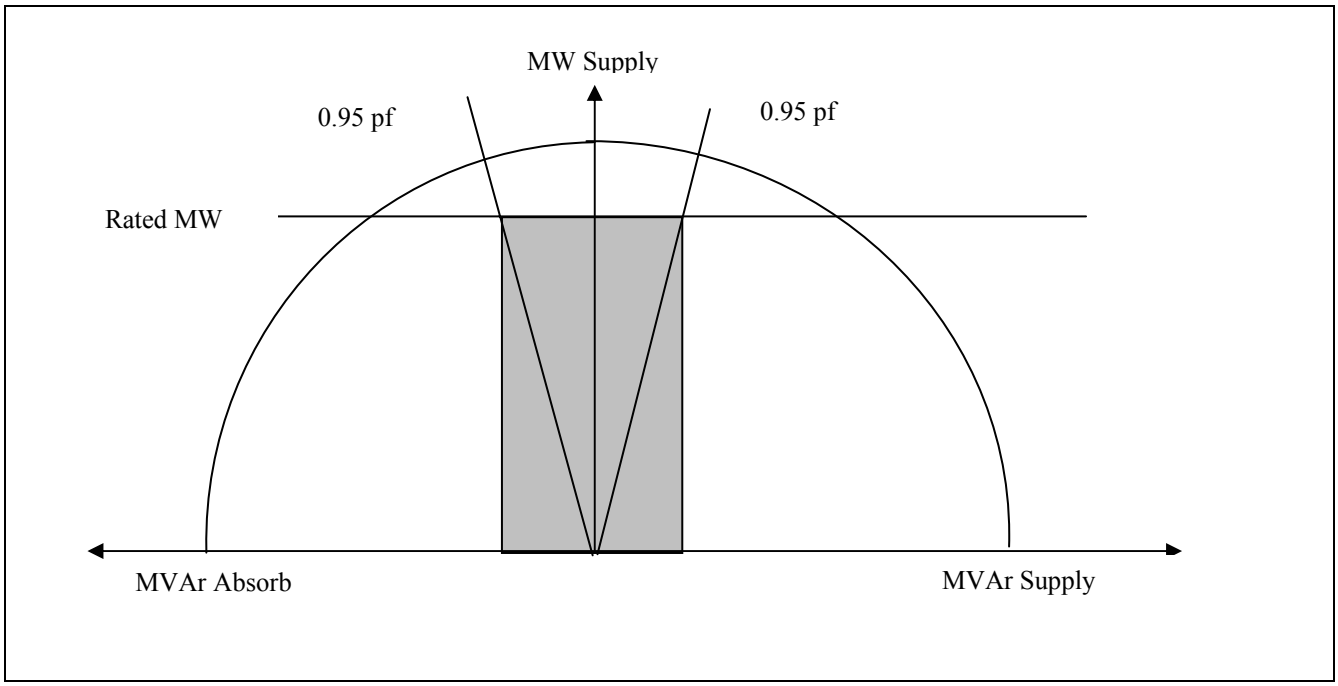
Figure 3.1 *Synchronous generating unit.* Minimum *reactive power capability* requirements at *generator* terminals shown shaded



(2) Each *induction generating* unit, while operating at any level of power output, must be capable of supplying or absorbing at its *connection point* an amount of *reactive power* that at the rated active power output of the generating unit at nominal voltage would result in a *power factor* of less than or equal to 0.95; Refer to Figure 3.2 for details.

(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 3.3.4.1(b)(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 *access contract.*

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

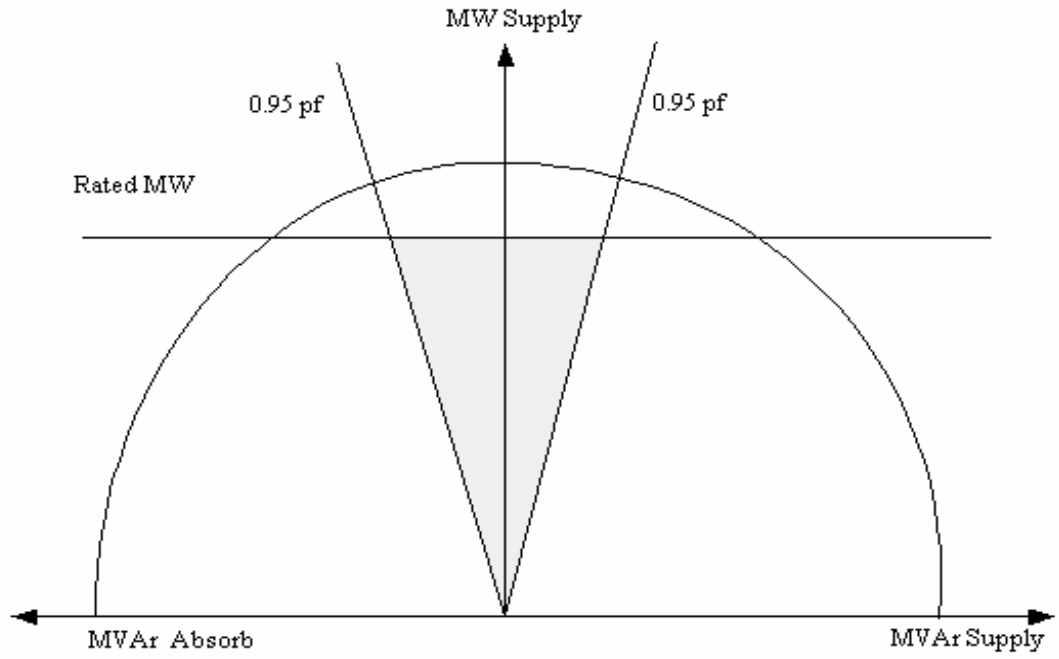


(4) Each *inverter coupled generating unit* or *converter coupled generating unit* must be capable of supplying or absorbing *reactive power* such that at the inverter or converter *connection point* the *power factor* is less than or equal to 0.95. Refer to Figure 3.3 for details.

(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 *access contract*.

(c) For *generating units* not described by clause 3.3.4.1(b), , the *power factor* requirements must be as advised by the *Network Service Provider* and included in the *access contract*. The 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



(d) If the *power factor* capabilities specified in clause 3.3.4.1(b) cannot be provided, the *Generator* must reach a commercial arrangement under the *access contract* with the *Network Service Provider* for the *supply* of the deficit in *reactive power* as measured at the relevant point of measurement.

(e) Each *generating unit*'s *connection* must be designed to permit the *dispatch* of the full *active power* and *reactive power capability* of the *facility* as specified in the *access contract* under all *power system* conditions contained in section 2.

3.3.4.2 *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*.

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

(a) **Overview**

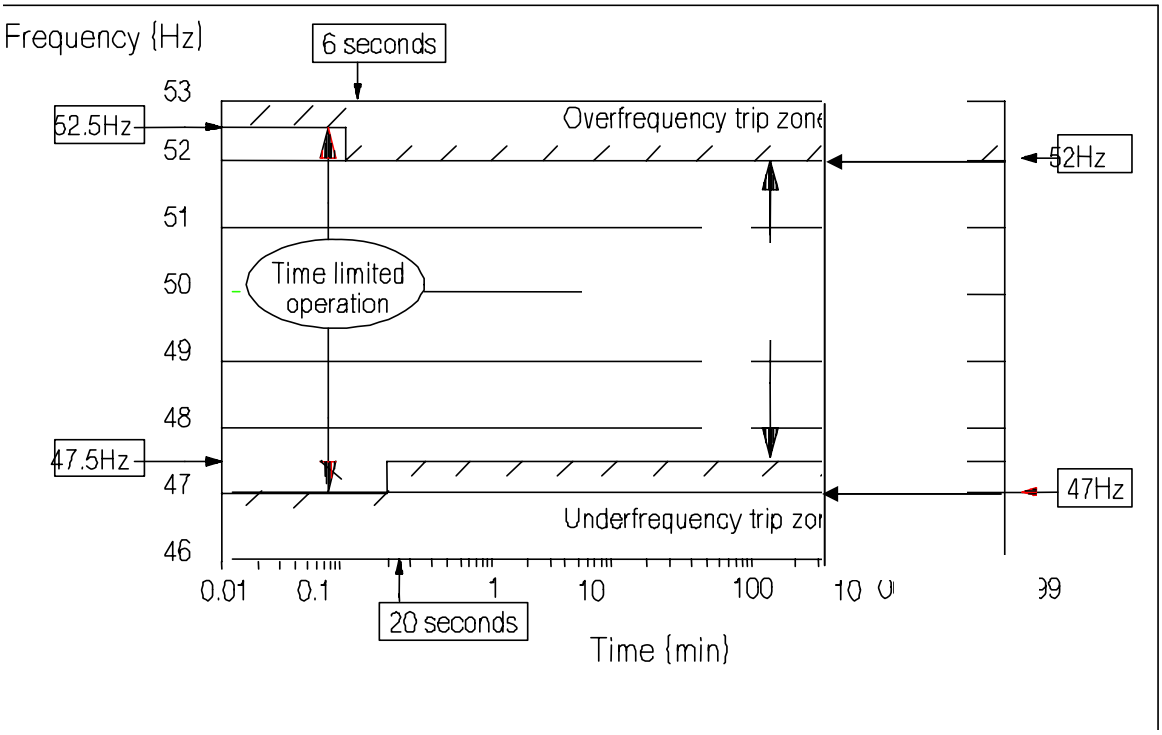
The following are design requirements for *generating units* and their auxiliary systems for continuous uninterrupted operation while being subjected to off-nominal *frequency* and *voltage* excursions. Continuous uninterrupted operation is defined in clause 3.3.4.3(h).

For *generating units connected* to the *distribution system*, 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 20 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*



(c) **Immunity to *Voltage* Excursions**:

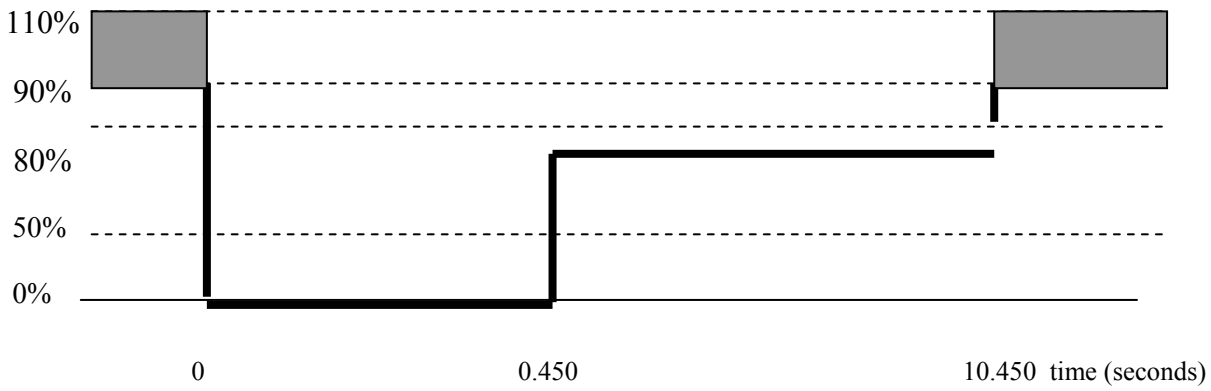
A *generating unit* and the *power station* in which the *generating unit* is located must be capable of continuous uninterrupted operation:

(1) for the range of *voltage* variations permitted by clause 2.2.2; and

(2) for *transmission* or *distribution transmission system* faults which cause the *voltage* at the *connection point* to drop below the nominal *voltage* for a period of up to 450 milliseconds (based on 330 kV CB fail *protection* time) in any one phase or combination of phases,

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*. See Figure 3.5a for details of this low *voltage* ride through requirement.

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



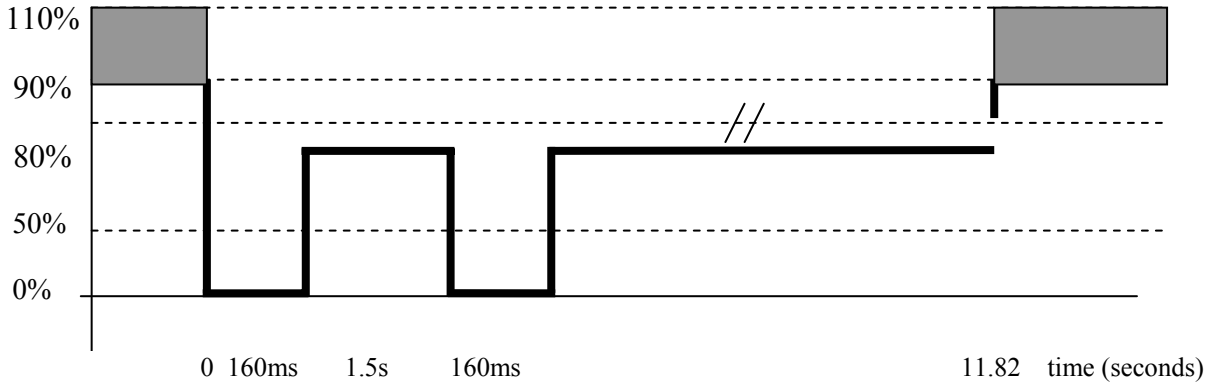
(d) **Immunity to Rate-of-Change-of-*Frequency***:

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 3.5b for details of the low *voltage* ride through requirement during auto-reclose operation.

Figure 3.5b - Off nominal *voltage* operation capability requirement for *generating units* during auto-reclose operation



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

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.

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

Each *generating unit* must be fitted with a governor and a *voltage* regulator so that, following the occurrence of any *credible contingency event* and *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* and *reactive power* sufficient to ensure that the *connection point voltage* is within the range for continuous uninterrupted operation for that *generating unit*.

(h) **Continuous Uninterrupted Operation**:

For the purposes of this clause 3.3.4.3, 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) the *active power* output returns to the *generating unit's* pre-fault electric power output within 200 milliseconds after the *voltage* has returned to between 80% to 110% of nominal *voltage*. In making this assessment, any variation in *active power* output for *non-synchronous generating units* due to variation in the primary source of energy must also be allowed for; and

(3) he *reactive power* control mode in which the *generating unit* was operating prior to the *credible contingency event* occurring does not change.

3.3.4.4 Sudden Reduction in Active Power Requirement

A *generating unit* must be capable of continuous uninterrupted operation as defined in clause 3.3.4.3(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* and the required *active power generation* remains above the *generating unit's* minimum *active power generation* capability.

3.3.4.5 Ramping Rates

(a) A *scheduled generating unit*, in a thermally stable state, must be capable of increasing or decreasing *active power generation* in response to a manually or remotely initiated order to change the level of generated *active power* at a rate not less than 5% of the *generator machine's nameplate rating* per minute.

(b) A *non-scheduled generating unit* must not increase or decrease its *active power generation* at a rate greater than 15% of the *generator machine's nameplate rating* per minute.

3.3.4.6 Safe Shutdown without External Electricity *Supply*

A *generating unit* must be capable of being safely shut down without an electricity *supply* being available from the *transmission* or *distribution system* at the relevant *connection point*.

3.3.4.7 Restart Following Restoration of External Electricity *Supply*

(a) A *generating unit* must be capable of being restarted and synchronised to the *transmission 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.

Examples of unreasonable delay in the restart of a *generating unit* are:

- delays not inherent in the design of the relevant start-up *facilities* and which could reasonably have been eliminated by the relevant *Generator*; and
- the start-up *facilities* for a new *generating unit* not being designed to minimise start up time delays for the *generating unit* following loss of external supplies for 2 hours or less and which could reasonably have been eliminated by the relevant *Generator*.

(b) The maximum restart time, agreed by the *Generator* and the *Network Service Provider*, must be specified in the *access contract*.

3.3.4.8 *Protection* of *Generating Units* from *Power System* Disturbances

(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 3.3.4.3 for continuous uninterrupted operation.

(b) The abnormal *conditions* referred to in clause 3.3.4.8(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 3.3.4.8(a) must be consistent with *power system* performance requirements specified in section 2 and must be approved by the *Network Service Provider*.

3.3.4.9 *Generating Unit Transformer*

(a) **Transformer Impedance**:

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

(b) **Vector Group**:

A *generating unit transformer's* vector group must be agreed with the *Network Service Provider*. The vector group must be compatible with the *power system* at the *connection point* and preference may be given to vector groups with a zero sequence opening between high *voltage* and low *voltage* windings.

(c) **Tap Changing**:

A *generating unit transformer* of a *generating unit* or *wind farm* must be capable of on-load tap-changing within the range specified in the relevant *access contract*.

3.3.4.10 De-energisation of *Generator* Circuits

The *Network Service Provider's* relevant circuit breaker may be used as a point of de-energisation, instead of the main switch specified in clause 3.2.2 provided that the *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(b);

(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*.

Under the relevant *access contract*, 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* as a result of the *Generator*'s electing to use any *Network Service Provider's* circuit breaker to clear a fault under clause 3.3.4.10(c).

3.3.5 Monitoring and Control Requirements

3.3.5.1 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 3.3.5.1(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*.

3.3.5.2 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* 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 3.3.5.2(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.

3.3.5.3 Communications *Equipment*

(a) A *User* 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 *Equipment*

(1) Subject to clause 3.3.5.3(c)(2), a *User* must provide and maintain dedicated *equipment* by means of which routine and emergency control telephone calls may be established between the *User's* responsible engineer or *operator* and *System Management* or *Network Service Provider*, whichever is applicable.

(2) Where the *Network Service Provider's SCADA system* is available to carry routine and emergency control telephone calls of the kind referred to in clause 3.3.5.3(c)(1), the *Network Service Provider* must make that system available on such basis as the *User* and the *Network Service Provider* agree in the relevant *access contract*.

(3) The *equipment* provided, including the interface requirement between the *Network Service Provider's equipment* and the *User's equipment*, must be as specified by the *Network Service Provider*.

(d) Backup Speech *Equipment*

(1) A *User* must provide a separate dedicated telephone link or other backup speech *equipment* for the *primary equipment*.

(e) Where suitable *equipment* cannot be viably sourced from a third party, the *Network Service Provider* may provide and maintain a separate telephone link or radio installation in accordance with the provisions of an *access contract*. This service, if provided by the *Network Service Provider*, includes responsibility for radio system planning and for obtaining radio licences for *equipment* used in relation to the *transmission and distribution systems*.

3.3.5.4 *Frequency Control*

(a) All *generating units* must have an automatic variable speed 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 (every four seconds) to allow for *changes* in *associated loads* and for *changes* in *frequency* of the *transmission and distribution system* and in a manner to sustain high initial response.

For steam *generating units*, this mode is known as the coordinated boiler follow mode.

(c) A *User* must, unless *System Management* instructs otherwise, operate a *generating unit* in the mode specified in clause 3.3.5.4(b).

(d) **Deadband**

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 *synchronous generating units*:

(A) The overall response of a *synchronous 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 up to 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 *synchronous generating unit* must also be capable of achieving a reduction in the *generating unit*'s *active power* output of up to 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 *access contract*, and the *Generator* must ensure that the *generating unit* responds in accordance with that *access contract*.

(D) *Thermal generating units* must be able to sustain *load change*s of at least 10% for a *frequency* decrease and 20% for a *frequency* increase if *change*s occur within the above limits of output. Multiple fuel *generating units* must have the same response to the system *frequency* changes regardless of which fuel type they are running on at any given time.

(2) For *non-synchronous generating units*:

(A) The overall response of a *non-synchronous generating unit* for *power system frequency* excursions must be settable and 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*.

(B) *Non-synchronous generating units* utilising technologies which intrinsically allow the control of *active power* output must be equipped with such controls to facilitate *frequency* control.

For example, wind turbines with pitch control can control electric power output relative to the maximum *energy* that can be extracted from the wind. Hence wind turbines must have pitch control fitted.

(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 a time to be specified in the relevant *access contract*.

This time is typically 6 seconds for *thermal generating units* and the new output must be sustained for 30 seconds. The time is typically 30 seconds for hydro *generating units* and the new output must be sustained indefinitely.

(2) For *non-synchronous generating units*, or any *frequency* disturbance, a *generating unit* must achieve at least 90% of the maximum response expected within a time to be specified in the relevant *access contract*.

The time is typically 2 seconds for wind and solar *generating units* and the new output must be sustained indefinitely.

3.3.5.5 *Voltage Control System*

The overriding objective of a *generating unit's voltage control system* is to maintain the specified *voltage* range at the *connection point*. Each *Generator* must therefore provide sufficient *reactive power* injection into, or absorption from, the *transmission or distribution system* to meet the *reactive power* requirements of its *loads*, plus all *reactive power* losses required to deliver its real power output at system *voltages* within the ranges specified in the *access contract* for normal operation and contingency conditions..

(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 boost or droop.

(b) *Synchronous generating units* commissioned after the *Rules* commencement date must be fitted with fast acting *excitation control system*s utilising modern technology in accordance with *good electricity industry practice*. AC exciter, rotating rectifier or *static excitation systems* must be provided for any *generating units* with a rating greater than 30 MW or for smaller *generating units* within a *power station* with a total *active power* output capability in excess of 30 MW. *Excitation control system*s must provide *voltage* regulation to within 0.5% of the selected setpoint value.

(c) New non-synchronous *generating units* must be fitted with fast acting *voltage control systems* utilising modern technology. This may take the form of fast acting SVC, statcom, inverters etc. *Voltage control systems* must provide *voltage* regulation to within 0.5% of the selected setpoint value.

(d) *Synchronous generating units* commissioned after the *Rules commencement date* 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 *change*s 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* and the requirement will be determined from *power system* simulations.

(f) The following performance characteristics required for AC exciter, rotating rectifier and *static excitation system*s are specified in Table 3.1:

Table 3.1 Synchronous Generator Excitation 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	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
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	4
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	4
Settling time following any disturbance which causes an excitation limiter to operate.	second	5 maximum	5 maximum	4

Notes:

1. One per unit is that field *voltage* required to produce nominal *voltage* on the airgap 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 ±1% of its increment value.

4. *Voltage* overshoot is defined as the largest deviation of the terminal *voltage* over the step increment value during the transient state.

5. Field *voltage* means *generating unit* field *voltage*.

(g) The performance characteristics required for all other *voltage control systems* are specified in Table 3.2:

Table 3.2 Non-Synchronous Generator Voltage Control System Performance Requirements

Performance Item	**Units**	**Static Excitation**	**Notes**
***sensitivity*:** A sustained 0.5% error between the *voltage* reference and the sensed *voltage* will produce a VAr change of not less than 1.0 per unit.	gain	200 minimum	1
***voltage* rise time:** Time for *voltage* to rise from rated *voltage* to voltage at maximum VAr output following the application of a short duration impulse to the *voltage* reference.	s	0.05 maximum	2
Settling time with the generator connected to the network following a disturbance equivalent to a 5% step change in the sensed generator terminal *voltage*. Must be met at all operating points within the generator capability.	s	2.5 maximum	3
Settling time following any disturbance which causes maximum VArs to be delivered.	s	5 maximum	3

Notes:

1. *Voltage* control system with both proportional and integral actions should be capable of achieving a minimum equivalent gain of 200.

2. Rise time is defined as the time taken for the *reactive power* output to rise from 10% to 90% of the increment value.
3. Settling time is defined as the time taken for the generator terminal *voltage* to settle and stay within an error band of ±1% of its increment value.

(h) The structure and parameter settings of all components of the *excitation control system*, including the *voltage* 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 *change*d, corrected or adjusted in any manner without the prior written approval of the *Network Service Provider*.

(j) 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 made available to the *Network Service Provider* at least two *months* before the system tests stated in clause 4.1.3 are undertaken. Any new settings, if found necessary during the tests to improve performance, must be provided by the *Generator*.

(k) Excitation limiters must be provided for under excitation and over excitation 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 excitation limiter. Excitation limiters must not detract from the performance of any stabilising circuits and must have settings applied which are coordinated with all *protection systems*.

3.3.6 *Power station* Auxiliary *Transformer*s

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*.

3.3.7 Synchronising

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

(b) 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), that are capable of connecting the *User's* generating *equipment* to the *transmission or distribution system*.

(c) 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*.

3.3.8 Secure Electricity Supplies

A *Generator* must provide secure electricity supplies of adequate capacity for the operation of *equipment* performing metering, communication, monitoring, and *protection* functions for at least 8 hours after the loss of AC supplies to that *equipment*.

3.3.9 Design Requirements For Generator's *Substations*

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

3.3.10 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 *access contract*. The model must automatically initialise its parameters from *load* flow simulations. Once a simulation case has been compiled, *change*s in the *load* flow such as *change*s in *voltage*, *generating unit* output, *voltage* setpoint 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 system*s 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.

3.4 REQUIREMENTS FOR *CONNECTION* OF *LOADS*

3.4.1 Obligations of *Consumers*

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

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

(2) in accordance with any relevant *access contract* with the *Network Service Provider*.

(b) A *Consumer* must operate its *facilities* and *equipment* in accordance with any and all *directions* given by *System Management* or the *Network Service Provider* under these *Rules* or under any written law.

3.4.2 Overview

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

(b) 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 *facilities* must be determined by the *Network Service Provider* and will depend on the magnitude and other characteristics of the *Consumer'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) A *Consumer* 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*, the *Network Service Provider* or the performance of the *power system*.

(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* were *disconnected*.

Note: this requirement is intended to safeguard from transients caused by relatively large *Users* with a high proportion of motor *loads*; for example, to safeguard one mining operation from another.

3.4.3 Power Frequency Variations

A *Consumer* must ensure that the *equipment* connected to its *connection point* is capable of continuous uninterrupted operation (other than when the *facility* is faulted) if variations in *supply frequency* of the kind described in clause 2.2.1(c) occur.

3.4.4 Power Frequency Voltage Variations

A *Consumer* 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.

3.4.5 Provision of Information

(a) Before *connection* to the *transmission or distribution system*, a *Consumer* 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 load* and that *connection* of the *Consumer's load* will not have an adverse impact other *Users,* or on the performance of the *power system.*

(b) The specific data that must be provided by a *Consumer* in respect of a particular *connection point* will depend on characteristics of the *Consumer's loads*, the *power transfer* capacity of the *connection point* as specified in the relevant *access contract*, 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*;

(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 *transformer*s, including measurement *transformer*s 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*.

Typically, a small domestic Consumer will only be required to provide the data referred to in clauses 3.4.5(b)(12)and clause 3.4.5(b)(13).

(c) In addition to the requirements in clause 3.4.5(a) and (b), the *Consumer* must provide load data reasonably required by the *Network Service Provider*. Details of the kinds of data that may be required are included in Attachment 3 and Attachment 9.

3.4.6 Design Standards

(a) The *equipment connected* to a *Consumer's connection point* must comply with the relevant *Australian Standard*s as applicable at the time of first installation of the *equipment*, the *Electricity (Supply Standard and System Safety) Regulations 2001* (WA), *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 *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 connection point* must coordinate with the *equipment* installed on the *power system*.

(d) If a *Consumer* connects a *transformer* directly to a *connection point* the *transformer* type must be agreed with the *Network Service Provider.* Preference will be given to *transformer*s with a zero sequence opening between high *voltage* and low *voltage* windings and to a type that is compatible with the system at the *connection point*.

3.4.7 *Power factor* Requirements

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

Table 3.3 *Power factor* Requirements (*Loads*)

Permissible Range	
Supply Voltage (nominal)	*Power factor* Range (half-hour average, unless otherwise specified by the *Network Service Provider*)
220kV / 330 kV	0.96 lagging to unity
66kV / 132 kV	0.95 lagging to unity
<66kV	0.9 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 an *access contract*.

(c) The *Network Service Provider* may permit a lower lagging or leading *power factor* where this will not reduce 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 for *Consumer's' Substations*

Equipment in or for any *Consumer'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 2.2;

(d) earthing of primary *equipment* in the *substation* must be in accordance with the Electricity Supply Association of Australia Safe Earthing Guide, *AS* 3000 and *Western Australian Electrical Requirements*. The earthing system must satisfy these requirements without any reliance on the *Network Service Provider's equipment*;

(e) *synchronisation facilities* or reclose blocking must be provided if *generating units* are *connected* through the *substation*; and

(f) insulation levels of *equipment* in the *substation* must coordinate with the insulation levels of the *transmission and distribution system* to which the *substation* is *connected* without degrading the design performance of the *transmission and distribution system*.

3.4.9 *Load shedding Facilities*

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

3.4.9.1 Installation and Testing of *Load shedding Facilities*

A *Consumer* that controls a *load* subject to *load shedding* in accordance with clause 2.3.1(c) must:

(a) provide, install, operate and maintain *equipment* for *load shedding*;

(b) co-operate with the *Network Service Provider* in conducting periodic functional testing of the *load shedding equipment*, which must not require *load* to be *disconnected*;

(c) apply under*frequency* settings to relays as determined by the *Network Service Provider*; and

(d) apply under*voltage* settings to relays as determined by the *Network Service Provider*.

3.4.10 Monitoring and Control Requirements

3.4.10.1 Remote Monitoring

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

(1) provide *remote monitoring equipment* to enable *System Management* 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*; and

(2) upgrade, modify or replace any *RME* already installed in a *User's substation* where the existing *RME* is, in the opinion of the *Network Service Provider*, no longer fit for purpose and notice is given in writing to the relevant *Consumer*.

(b) An *RME* provided, upgraded, modified or replaced (as applicable) in accordance with clause 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.

(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 v*oltages* throughout the *equipment*, including *voltage* on the *Network Service Provider* side of main switch.

3.4.10.2 *Network Service Provider's* Communications *Equipment*

Where *remote monitoring equipment* is installed in accordance with clause 3.4.10.1, the *User* must provide communications paths (with appropriate redundancy) between the *remote monitoring equipment* and a communications interface in a location reasonably

acceptable to the *Network Service Provider*. Communications systems between this communications interface and the relevant *control centre* are the responsibility of the *Network Service Provider* unless otherwise agreed.

3.4.11 Secure Electricity Supplies

All *Users* must provide secure electricity supplies of adequate capacity to provide for the operation for at least 8 hours of *equipment* performing metering, communication, monitoring, and *protection* functions, on loss of AC supplies.

3.5 CONSUMER'S *PROTECTION* REQUIREMENTS

3.5.1 Overview

(a) The requirements of this clause 3.5 apply only to a *Consumer's protection* that is necessary to maintain *power system security. Protection* installed solely to cover risks associated with a *Consumer's equipment* is at the *Consumer's* discretion. The extent of a *Consumer's equipment* that will need to conform with the requirements of this clause 3.5 will vary from installation to installation. Consequently, each installation will need to be assessed individually by the *Network Service Provider*.

(b) The requirement for *protection* in respect of any *Consumer'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*.

> This clause is intended to cover the situation where a *connection asset* (such as a circuit breaker) that is used to disconnect a *load* from the *transmission or distribution system* is owned by a *Consumer*. This situation, while not common, does occur on the SWIS.

(c) All *Consumer's* equipment connected to the *transmission* or *distribution system* (referred to as *Consumer's transmission system equipment* or *User's distribution system equipment*, as applicable) must be protected by *protection systems* or devices that automatically disconnect any faulty circuit from the *transmission* or *distribution system*.

(d) A *Consumer* and the *Network Service Provider* must cooperate in the design and implementation of *protection systems*, including with regard to:

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

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

(3) co-ordination of *protection system* settings to ensure inter-operation.

Any reliance on the *Network Service Provider's protection system* to protect an item of *User's equipment*, and vice versa, including the use of *current transformers and voltage transformers* (or equivalent) and the tripping of circuit breakers, must be included in the *access contract*.

(e) A *Consumer's protection systems* must be located on the relevant *Consumer's equipment* and must discriminate with the *Network Service Provider's protection systems* and that of other *Users*.

(f) Except in an emergency, a *User* must notify the *Network Service Provider* at least 5 *business days* prior to taking a *protection* of any *User's transmission system equipment* out of service.

(g) The installation and use of *automatic reclose equipment* in a *Consumer's facility* is permitted only with the prior written agreement of the *Network Service Provider*.

(h) *Consumer's* must ensure that their *protection* settings coordinate with the *Network Service Provider's protection* settings and must provide their *protection* data to the *Network Service Provider*. A *Consumer* must not adjust its *protection* settings without the *Network Service Provider's* approval.

3.5.2 Specific *Protection* Requirements for *Generator Facilities*

(a) The requirements of this clause 3.5.2 do not apply to a *generation facility* where the total rating of all *generating units* in that generating facility is less than 10 MW and which are *connected* to the *distribution* system at a nominal *voltage* below 66 kV. For that case, the *protection* requirements are specified in clauses 3.6 and 3.7.

(b) 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* 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* must be capable of meeting the *critical fault clearance time*. Where there is no *critical fault clearance time* both independent *protections* must meet the relevant maximum *total fault clearance times* specified in clause 2.9.4.

(c) The duplicate *protection schemes* required by clause 3.5.2(b) must incorporate full redundancy of *secondary equipment* so that a failure of one *protection scheme* to operate as a result of *a secondary equipment* fault will not prevent the second *protection scheme* from operating as designed. In addition, the design must make it possible to test and maintain either *protection scheme* without interfering with the other.

(d) 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(b) 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*;

(3) prevention of the *Generator's generating unit* from energising de-energised *Network Service Provider equipment*, or energising and *supply*ing an otherwise isolated portion of the *transmission or distribution system*;

(4) adequate *protection* of the *Generator's equipment* without reliance on back up from the *Network Service Provider's protection* except as permitted in clause 3.3.4.10; and

(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* protection system must send a trip signal to an alternative circuit breaker, which may be provided by the *Network Service Provider* in accordance with clause 3.5.1(d), in order to clear the fault.

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

(f) If a *generating unit* is *connected* to the *distribution system* the *Generator* must provide a circuit breaker close inhibit interlock with the feeder circuit breaker at the *Network Service Provider's zone substation* in accordance with the requirements specified by the *Network Service Provider*.

This interlock is required in addition to the islanding protection specified in clause 3.5.2(d)(3) on account of the potential safety hazard if a de-energised *distribution feeder* was energised by an *embedded generating unit*.

3.5.3 Specific *Protection* Requirements for *Consumer Facilities*

(a) A *Consumer* must provide a *main protection system* to disconnect from the *power system* any faulted element within its *protection* zone within the *total fault clearance time* agreed with the *Network Service Provider* and specified in the relevant *access contract*. For *equipment* supplied from *connection points* with a nominal *voltage* of 33 kV or greater, the *total fault clearance times* are the relevant times specified in clause 2.9.4 unless a *critical fault clearance time* applies in accordance with clause 2.9.5, in which case the required *total fault clearance time* is the *critical fault clearance* time.

(b) If the *Consumer'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) 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). If a circuit breaker fails, the *Consumer'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.

3.6 REQUIREMENTS FOR *CONNECTION* OF SMALL *GENERATING UNITS* TO THE *DISTRIBUTION* NETWORK

3.6.1 Overview

This clause 3.6 addresses the particular requirements for small *generating units* and groups of small *generating units* of aggregate rated capacity up to 10 MW (small *power stations*) *connected* to the *distribution system* but not subject to dispatch by *System Management* in accordance with the Wholesale Electricity Market Rules. This does not apply to energy systems rated at up to 30 kVA and connected to the *low voltage* system via inverters, in respect of which clause 3.7 applies. It does not diminish the obligation of any *User* to comply with the other requirements of these *Rules,* except where specifically stated in this clause 3.6.

The issues addressed by this clause 3.6 are:

1. the possibility that *generating units* embedded in *distribution systems* may affect the *quality of supply* to other *User*s, cause reverse *power transfer*, use up *distribution system* capacity, create a *distribution system* switching hazard and increase risks for operational personnel; and

2. the possibility that a small *power station connected* to a *distribution system* could become islanded on to a de-energised part of the *distribution system* resulting in safety and *quality of supply* concerns.

3.6.2 Categorisation of *Facilities*

(a) This clause 3.6 covers *generating units* of all types, whether using renewable or non-renewable *energy* sources.

(b) Unless otherwise specified, technical requirements for non-*synchronous generating units* will apply at the *connection point*, rather than at the *generator machine* terminals, to allow flexibility in design.

(c) Unless otherwise specified, technical requirements for *synchronous generating units* will apply at the *generator machine* terminals.

(d) In this clause 3.6, *connection points* for small *power stations* are characterised as:

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

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

(e) **Modes of Operation**

In this clause 3.6, the mode of operation of a *generating unit* in a small *power station* is characterised as:

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

3.6.3 Information to be provided by the *Generator*

(a) A *Generator* must provide all information in relation to the operation and configuration of that small *power station* as is required by the *Network Service Provider* to ensure that the operation and performance standards of the *distribution system,* or other *Users,* are not adversely affected by the operation of the *power station*. Details of the kinds of information that may be required are included in Attachment 3 and Attachment 4.

(b) In order to assess the impact of the *equipment* on the operation and performance of the *distribution system* or on other *Users,* the *Network Service Provider* may require a *Generator* to provide data on:

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

(2) flicker coefficients and harmonic profile of the *equipment* (where applicable).

(c) *Load* data must be provided in the form of:

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

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

or such other form as specified in the *access contract*.

(d) 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) Data on power quality characteristics (including flicker and harmonics) in accordance with IEC 61400-21 must be provided for all wind turbines.

(f) 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.

3.6.4 Safety and *Reliability*

(a) The requirements imposed on a *Generator* by this clause 3.6 are intended to provide minimum safety and *reliability* standards for the *distribution system* and other *Users*. Subject to meeting these requirements, a *Generator* must design 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 *User*s are paramount and *access application*s 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) 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 *distribution 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 modify its relevant *equipment*.

(d) Unless otherwise agreed in the relevant *access contract*, the *Network Service Provider* may require a *Generator* not to operate *equipment* in abnormal *distribution system* operating conditions.

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

Table 3.5 lists specific provisions of clause 3.3 that apply to small *power stations* in addition to the requirements of this clause 3.6.

Table 3.5 - Specific paragraphs of clause 3.3 applicable to small *distribution-connected generating units* in the range 30 kVA to 10 MW

Clause	Requirement	Notes
3.3.4.1	*Reactive power capability*	
3.3.4.3	*Generating unit* response to disturbances	
3.3.4.8	Protecting of *generating units* from *power system* disturbances	In most cases compliance with this clause 3.6 will ensure compliance with clause 3.3.4.8
3.3.5.4	*Frequency control systems*	Applicable requirements
3.3.5.5	Voltage *control system*s	Applicable requirements

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 *access contract*.

(c) All *generating units* in small *power stations*, *synchronous* or otherwise, must provide *voltage* control within their own *reactive power* capabilities in accordance with clause 3.3.4.1 and the applicable control strategy, limits and ranges set out in clause 3.3.5.5. *Generators* must, if necessary, reduce *active power* or *reactive power* output or *disconnect* from the *distribution system* to ensure *connection point voltage* remains within the stipulated limits.

3.6.7 *Connection* and Operation

3.6.7.1 *Generators' Substations*

Generators' substations through which *generating units* are *connected* to the *distribution system* must comply with the requirements of clause 3.4.8.

3.6.7.2 Main Switch

(a) Each *facility* at which a *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) 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 isolation 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.

3.6.7.3 Synchronising

(a) For a *synchronous generating unit* in a small *power station*, a *Generator* must provide manual or automatic synchronising *equipment* at each *generating unit* circuit breaker.

(b) Unless interlocking is provided as outlined in clause 3.5.2(e), 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 *distribution system*.

(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 Safe Shutdown without External *Supply*

A *generating unit* must be capable of being safely shut down without electricity *supply* available from the *distribution system*.

3.6.8 Power Quality and *Voltage Change*

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

(b) The step *voltage* change at the *connection point* for *connection* and *disconnection* must comply with the requirements of clause 2.2.3. These requirements may be achieved by *synchronising* individual *generating units* sequentially. On low *voltage* feeders, *voltage change*s up to 5% may be allowed in some circumstances with the approval of the *Network Service Provider*.

(c) The steady state *voltage* rise at the *connection point* resulting from export of power to the *distribution system* must not exceed 2% and must not cause the *voltage* limits specified in clause 2.2 to be exceeded.

(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 MW 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 MW 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 *control centre* for monitoring and control for *generating units* exporting 1 MW and above to the *distribution system*. For *generating units* exporting below 1 MW, 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 room*. For *generating units* exporting above 1 MW, a dedicated telephone link or other dedicated communication channel may be required.

3.6.10 *Protection*

3.6.10.1 General

(a) A *Generator* must provide, as a minimum, the *protection* functions specified in Table 3.6 in accordance with the aggregate rated capacity of *generating units* in a small *power station* at the *connection point*. Table 3.6 covers only the minimum

protection schemes considered necessary for safe and *reliable* operation of the *distribution system*. The *Generator* must provide any necessary additional *protection schemes* to meet the requirements of clause 3.6.4.

(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.

(c) The design of a *User'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 *User*s. This may be achieved by:

(1) providing back-up *protection schemes*; or

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

(d) All *protection equipment* must comply with the IEC 60255 series of standards. Integrated control and *protection equipment* may be used provided that it can be demonstrated that the *protection* functions are functionally independent of the control functions, i.e. failure or maloperation of the control features will not impair operation of the *protection system*.

(e) For retrofits of installations existing at the *Rules commencement date*, to provide for bumpless transfer, the *disconnection* timer for bumpless transfers must comply with IEC 60255. Other existing *protection equipment* is not required to be upgraded to be IEC 60255 compliant. Automatic transfer switches must comply with *AS* 60947.6.2 (2004) or other applicable standards.

Table 3.6 Summary of *protection* requirements for small *generating units*

Protection required for *distribution system* (Note 1)		Permanent parallel operation Occasional parallel operation					Short term test parallel				Bumpless Transfer	
		HV generating *equipment*		LV generating *equipment*			HV generating *equipment*	LV generating *equipment*				
Type	Reference	No export	Export	Aggregate capacity kVA			No export	Aggregate capacity kVA			Rapid (≤ 1s)	Gradual (≤ 60s)
				<150	150 - 250	>250		<150	150 - 250	>250		
Under / over *voltage* & *frequency*	Clause 3.3.4.3	×	×	×	×	×	×	×	×	×	×	×
Loss of mains (islanding)	Clause 3.3.4.8	×	×	×	×	×	×			×		
Rate of change of *frequency*		×	×	×	×	×	×			×		
Overcurrent	Clause 3.7.7.4	×	×	×	×	×	×	×	×	×	×	×
Earth fault	Clause 3.7.7.4	×	×	×	×	×	×		×	×	×	×
Sensitive earth fault		×	×				×					
Reverse power	Clause 3.3.4.8	×	×			×						
*Directiona*l overcurrent		×	×			×						
Neutral *voltage* displacement		×	×	×	×	×	×	×	×	×		
Loss of DC *supply* to *protection*	Note 2	×	×		×	×	×			×		
Pole slipping	3.6.10.2	×	×			×						

Disconnection by timer							×	×	×	×	×	×

Notes:

1. The symbol × indicates required *protection*.

2. Loss of a *protection* direct current *supply* must immediately trip all switches that depend on that *supply* for operation of their *protection*.

3.6.10.2 Pole Slipping

Notwithstanding the requirements of Table 3.6, where it is determined that the disturbance resulting from loss of *synchronism* is likely to exceed that permitted in clause 2.2, the *User* must install a pole slipping *protection scheme*.

3.6.10.3 Islanding *Protection* and Intertripping

(a) For sustained parallel operation, islanding *protection* 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*. In some cases the *protection* specified in Table 3.6 may meet this requirement for one of the two required functional types. Nevertheless, the *Generator* must demonstrate that two different functional types means of islanding *protection* have been provided.

(b) 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*.

> It should be assumed that the *Network Service Provider* will always attempt to auto-reclose to restore *supply* following transient faults.

(c) 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*.

3.6.10.4 *Protection* of *Generator's equipment*

(a) 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*.

(b) Any failure of the *Generator's* tripping supplies, *protection apparatus* or circuit breaker trip coils required under clause 3.6.10 must be alarmed within the *Generator's facility* and operating procedures put in place to ensure that prompt

action is taken to remedy such failures. As an alternative to alarming, *generating unit* main switches may be tripped automatically.

3.6.11 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 backup;

(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 ENERGY SYSTEMS TO THE LOW VOLTAGE DISTRIBUTION SYSTEM VIA INVERTERS

3.7.1 Scope

(a) This clause 3.7 addresses the particular requirements for the connection of 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 connected energy systems, the requirements of clause 3.6 apply.

(b) 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 *Customer* 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

The nominal network *voltages* and maximum energy system capacities for which these requirements apply are as follows:

Nominal Voltage	Maximum Capacity
240 V single phase	10 kVA
415 V three phase	30 kVA

For simplicity, it is assumed that the full rated capacity of the inverter is capable of being exported to the *distribution system*.

3.7.3 Relevant Standards

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

(b) Inverter systems must satisfy the requirements of *Australian Standard* 4777 "Grid connection of energy systems via inverters" as published and revised. The following parts of this standard apply:

(1) *AS* 4777.1 – 2005 Part 1 Installation requirements.

(2) *AS* 4777.2 – 2005 Part 2 Inverter requirements.

(3) *AS* 4777.3 – 2005 Part 3 Grid protection requirements.

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

(d) A type-test report or type-test certificate from an independent and recognised certification body showing compliance of inverter plant with *AS* 4777.2 (2005) must be supplied to the *Network Service Provider*.

(e) 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

The *User* must make provision for both an import and export meter. Should an additional meter be required for the export power meter, the *User* may need to install an additional meter box or rearrange the existing meter box to accommodate a second meter.

3.7.5 Safety

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

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 *Customer's* installation must display warning labels. These labels must be maintained in good order. Clause 3.7.9 outlines a minimum set of labels to be installed. If the Inverter energy system is connected to a sub board, all up-stream (i.e. towards the main switchboard) switches and switchboards must also be labelled.

3.7.5.2 Security of operational settings

Where operational settings are applied via a keypad or switches, adequate security must be employed to prevent tampering or inadvertent/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 the inverter system.

3.7.6.2 Required switches

All switches must be suitably rated for the required duty. Figure 3.6 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 3.7.

Table 3.7 Inverter Energy System Connection Modes

Customer Main Switch (CMS)	Inverter Supply Switch (ISS)	Operating Mode
OFF	OFF	All power off
OFF	ON	Supply to the consumer from the inverter only
ON	OFF	Inverter isolated from the Western Power network
ON	ON	Inverter connected to the network

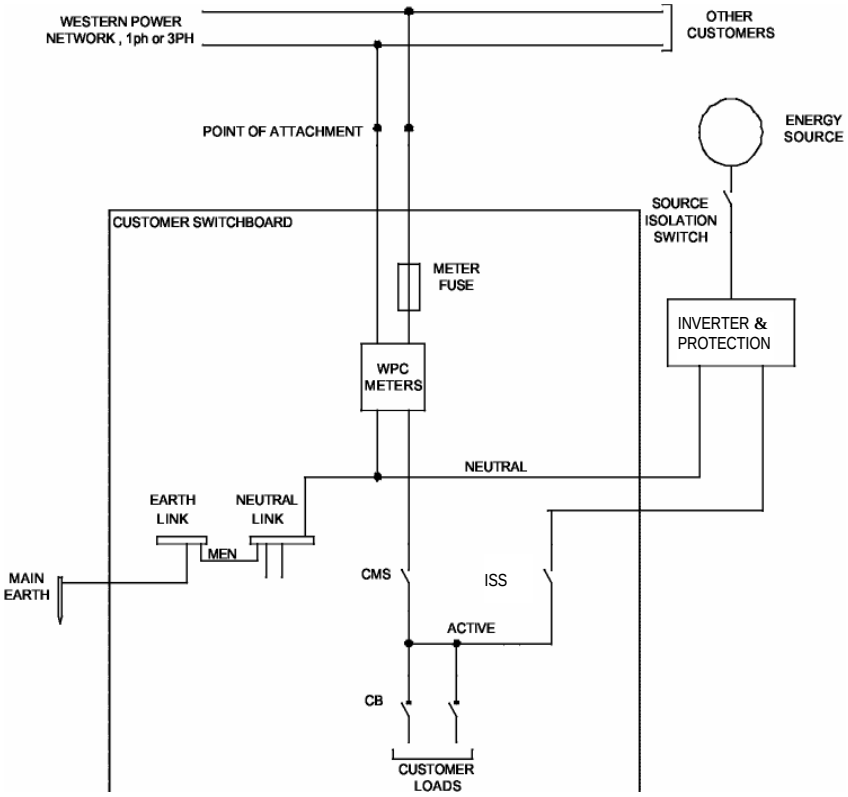


Figure 3.6 Schematic Diagram for the Connection of an Inverter Energy System

(a) *Customer Main Switch (CMS)*

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

(b) *Inverter Supply Switch (ISS)*

A suitably rated inverter supply switch is required to isolate and protect the entire Inverter energy system as shown in Figure 3.6. 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. See section 3.7.5.1.

(c) *Source Isolation Switch*

A Source Isolation Switch is required to isolate the energy source as shown in Figure 3.6. The source isolation switch must be rated for DC operation.

3.7.7 Protection

An Inverter energy system *connected* to the *distribution system* must meet the requirements of relevant standards in accordance with clause 3.7.3 and the following requirements below.

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.

3.7.7.2 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

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*.

3.7.7.5 Voltage limits

The Inverter voltage limits must be set according equipment capability and *AS* 4777. However the Inverter energy system must remain connected for voltage variations within the limits of Table 3.8 unless otherwise agreed with the *Network Service Provider*. The network *voltage* range is based on 5-minute averages of the RMS value.

Table 3.8 The *Network Service Provider* 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

The Inverter frequency limits must be set according equipment capability and *AS* 4777. However the Inverter Energy System must remain connected for frequency variations between 47.5 Hz and 52 Hz unless otherwise agreed with *Network Service Provider*.

3.7.8 Commissioning and Testing

3.7.8.1 Exclusion of clause 4.2

Where it applies, this clause 3.7.8 applies to the exclusion of clause 4.2.

3.7.8.2 Commissioning

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

(b) In commissioning *equipment* installed under this clause 3.7, 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 that specified in clause 3.7.9.

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

(5) Operational settings are secure as specified.

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

(7) The delay in reconnection following restoration of normal supply is greater than 1 minute.

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

3.7.8.3 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*.

(b) Inverter protection systems must also be tested for correct functioning at regular intervals not exceeding 5 years. The *Customer* must arrange for a suitably qualified person to conduct the tests. Results of tests must be certified by a Chartered Professional Engineer with NPER standing and supplied to the *Network Service Provider*.

3.7.9 Signage Guide

Table 3.9 provides examples of signage required at the various locations. Note that words in italics would change to describe the type of *generation*.

Table 3.9 Examples of required signage

Main switchboard and distribution board(s) upstream of distribution board where the Inverter energy system Is Connected. Lettering: 4 mm, 8 mm "WARNING" Colour: red, white letters Size: 120 * 60 mm	**WARNING** ***SOLAR* GENERATION PLANT CONNECTED** **ISOLATE *SOLAR* GENERATION**
Main switchboard or distribution board where the Inverter energy system is connected. Lettering: 4 mm, 8 mm "WARNING" Colour: red, white letters Size: 120 * 60 mm	**WARNING** **DUAL SUPPLY** **ISOLATE BOTH NORMAL AND *SOLAR* SUPPLIES** **BEFORE WORKING ON THIS SWITCHBOARD**
Customer Main Switch Lettering: 5 mm Colour: white, black letters Size: 75 * 30 mm	**NORMAL SUPPLY MAIN SWITCH**

Inverter Supply Switch Lettering: title 5 mm, words 4 mm Colour: white, black letters Size: 75 * 30 mm	***SOLAR* SUPPLY MAIN SWITCH** ***SOLAR* GENERATOR LOCATED IN** *(Location of solar Generator)*

4. INSPECTION, TESTING, COMMISSIONING, *DISCONNECTION* AND RE*CONNECTION*

4.1 INSPECTION AND TESTING

4.1.1 Right of Entry and 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*) (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 *access contract*;

(2) investigate any operating incident in accordance with clause 5.7.3;

(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 the *Network Service Provider* or *System Management* reasonably considers requires access to a *facility*, prior notice to the *facility* owner is not required. However, the *Network Service Provider* or *System Management*, 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 5.7.1.

(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 an *access contract*, that *access contract*.

(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) 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) 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;

(2) 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

(3) not create or cause to be created any mortgage, charge or lien over any such *equipment* or goods.

4.1.2 Right of Testing

(a) If the *Network Service Provider* or any *User* whose *equipment* is connected directly to the *transmission system* under an *access contract* (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 *access contract* (in this clause 4.1.2 the "equipment owner") may not comply with the *Access Code*, these *Rules* or the *access contract*, 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*. 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 Management*, which agreement must not be unreasonably withheld or delayed.

(e) Tests under this clause 4.1.2 may be conducted only by persons with the relevant skills and experience.

(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 which could have had an impact on the *security* of the *power system*, *System Management*, 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), 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) demonstrates that *equipment* does not comply with the *Access Code*, these *Rules* or the relevant *access contract*, then the *equipment* owner must:

(1) promptly notify the requesting party of that fact;

(2) promptly advise the requesting party of the remedial steps it proposes to take and the timetable for such remedial work;

(3) diligently undertake such remedial work and report at *monthly* intervals to the requesting party on progress in implementing the remedial action; and

(4) conduct further tests or monitoring on completion of the remedial work to confirm compliance with the relevant requirement.

4.1.3 Tests to Demonstrate Compliance with *Connection* Requirements for *Generators*

(a) (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, 3.6 or 3.7, as applicable, and the relevant *access contract* prior to commencing commercial operation. In addition, each *Generator* must cooperate with the *Network Service Provider* and, if necessary, *System Management* in carrying out *power system* tests prior to commercial operation in order 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 A9.1 of Attachment 10. The *Network Service Provider* must specify test requirements for non-synchronous *generation*.

(2) Special tests may be specified by the *Network Service Provider* or *System Management* where reasonably necessary to confirm that the *security* and performance standards of the *power system* 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 A9.2 of Attachment 10. 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) These compliance tests must only be performed after the machines have been tested and certified by a Chartered Professional Engineer 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, excitation limiters must be indicated on control transfer block diagrams and made available to the *Network Service Provider* before the tests.

(4) 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) 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*. The *Network Service Provider* or *System Management* 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) 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, 3.6 or 3.7, as applicable, and the relevant *access contract*. 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.

(c) If compliance testing or monitoring of in-service performance demonstrates that a *generating unit* is not complying with one or more technical requirements of clause 3.3 and the relevant *access contract* 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 the remedial steps it proposes to take and the timetable for such remedial work;

(3) diligently undertake such remedial work 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) If the *Network Service Provider* or, where relevant, *System Management* reasonably believes that a *generating unit* is not complying with one or more technical requirements of clause 3.3, 3.6 or 3.7, as applicable, and the relevant *access contract*, the *Network Service Provider* or *System Management* 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* that requested the test must reimburse the *Generator* for the reasonable expenses incurred as a direct result of conducting the tests.

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

(1) has reason to believe that a *generating unit* does not comply with one or more of the requirements of clause 3.3, 3.6 or 3.7, as applicable;

(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); or

(3) either:

(A) does not have evidence demonstrating that a *generating unit* complies with the technical requirements set out in clause 3.3, 3.6 or 3.7, as applicable; or

(B) holds the opinion that there is, or could be, a threat to the *power system security* or *stability*,

the *Network Service Provider* or, where relevant, *System Management,* 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*, 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) If:

(1) the *Network Service Provider* or, where relevant, *System Management*, gives a *direction* to a *Generator* under clause 4.1.3(e) and the *Generator* neglects or fails to comply with that *direction*; or

(2) the *Network Service Provider* or, where relevant, *System Management*, endeavours to communicate with a *Generator* for the purpose of giving a *direction* to a *Generator* under clause 4.1.3(e) but is unable to do so within a time which is reasonable, having regard for circumstances giving rise to the need for the *direction*,

then the *Network Service Provider* or *System Management*, as the case requires, may take such measures as are available to it (including, in the case of *System Management*, 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) A *direction* under clause 4.1.3(e) must be recorded by the *Network Service Provider* or *System Management*, as applicable.

(h) 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 Management* on request.

4.1.4 Routine Testing of *Protection Equipment*

(a) A *User* must cooperate with the *Network Service Provider* to test the operation of *equipment* forming part of a *protection scheme* relating to a *connection point* at which that *User* is *connected* to a *transmission or distribution system* and the *User* must conduct these tests:

(1) prior to the *equipment* at the relevant *connection point* being placed in service; and

(2) at intervals specified in the *access contract* or in accordance with an asset management plan agreed between the *Network Service Provider* and the *User*.

(b) A *User* must, on request from the *Network Service Provider*, demonstrate to the *Network Service Provider's* satisfaction the correct calibration and operation of the *User's protection* at the *User's connection point*.

(c) The *Network Service Provider* and, where applicable, a *User*, must institute and maintain a compliance program to ensure that each of its *facilities* of the following types, to the extent that the proper operation of any such *facility* may affect *power system security* and the ability of the *power system* to meet the performance standards specified in clause 2.2, operates reliably and in accordance with its relevant performance requirements specified in section 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 of periodic testing of the performance of those *facilities* upon *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 Management* 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 section 2.

4.1.5 Testing by *Users* of their own *Equipment* Requiring *Change*s to Agreed Operation

(a) If a *User* proposes to conduct a test on *equipment* related to a *connection point* and that test requires a *change* to the operation of that *equipment* as specified in the relevant *access contract*, or if the *User* reasonably believes that the test might have an impact on the operation or performance of the *power system*, the *User* must give notice in writing to the *Network Service Provider* at least 15 *business day*s in advance of the test, except in an emergency.

(b) The notice to be provided under clause 4.1.5(a) must include:

(1) the nature of the proposed test;

(2) the estimated start and finish time for the proposed test;

(3) the identity of the *equipment* to be tested;

(4) the *power system* conditions required for the conduct of the proposed test;

(5) details of any potential adverse consequences of the proposed test on the *equipment* to be tested;

(6) details of any potential adverse consequences of the proposed test on the *power system*; and

(7) the name of the person responsible for the coordination of the proposed test on behalf of the *User*.

(c) The *Network Service Provider* must review the proposed test to determine whether the test:

(1) could adversely affect the normal operation of the *power system*;

(2) could cause a threat to *power system security*;

(3) requires the *power system* to be operated in a particular way which differs from the way in which the *power system* is normally operated;

(4) could affect the normal metering of *energy* at a *connection point*;

(5) could threaten public safety; or

(6) could damage *equipment* at the *connection point*.

(d) If, in the *Network Service Provider's* opinion, a test could threaten public safety, damage or threaten to damage *equipment* or adversely affect the operation, performance or *security* of the *power system*, 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* 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*, when the test is complete.

(g) If the *Network Service Provider* approves a proposed test, the *Network Service Provider* and, where appropriate, *System Management*, 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*, with a report in relation to that test, including test results where appropriate.

4.1.6 Tests of *Generating units* Requiring *Change*s to Agreed Operation

(a) The *Network Service Provider* may, at intervals of not less than 12 *months* per *generating unit*, by notice to the relevant *Generator* accordingly, require the testing of any *generating unit connected* to the *transmission or distribution system* in order to determine analytic parameters for modelling purposes or to assess the performance of the relevant *generating unit*.

(b) The *Network Service Provider* must, in consultation with the *Generator*, propose a date and time for the tests but, if the *Network Service Provider* and the *Generator* are unable to agree on a date and time for the tests, they must be conducted on the date and at the time nominated by the *Network Service Provider*, provided that:

(1) the tests must not be scheduled for a date earlier than 15 *business day*s 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) The *Network Service Provider* must provide to a *Generator* such details of the analytic parameters of the model derived from the tests referred to in clause 4.1.6 for any of that *Generator*'s *generating units* as may reasonably be requested by the *Generator*.

4.1.7 *Power System* Tests

(a) Tests conducted for the purpose of either verifying the magnitude of the *power transfer capability* of the *transmission or distribution system* or investigating *power system* performance must be coordinated and approved by the *Network Service Provider*.

(b) The tests described in clause 4.1.7(a) must be conducted, if considered necessary by the *Network Service Provider* or *System Management*, 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 *change*s 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* 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) The *Network Service Provider* must notify all *Users* who could reasonably be expected to be affected by the proposed test at least 15 *business day*s before any test under this clause 4.1.7 may proceed and consider any requirements of those *Users* when approving the proposed test.

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

4.2 COMMISSIONING OF *USER'S EQUIPMENT*

4.2.1 Requirement to Inspect and Test *Equipment*

(a) A *User* must ensure that new or replacement *equipment* is inspected and tested to demonstrate that it complies with relevant *Australian Standards*, relevant international standards, these *Rules*, the *Access Code* and any relevant *access contract* 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 4.1.1(a).

4.2.2 Co-ordination During Commissioning

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:

(a) does not adversely affect other *Users* or affect *power system security* or *quality of supply* of the *power system*; and

(b) minimises the threat of damage to the *Network Service Provider's* or any other *User's equipment*.

4.2.3 Control and *Protection* Settings for *Equipment*

(a) Not less than 65 *business days* (or as otherwise agreed between the *User* and the *Network Service Provider*) prior to the proposed commencement of commissioning by a *User* of any new or replacement *equipment* that could reasonably be expected to alter materially the performance of the *power system*, the *User* must submit to the *Network Service Provider* sufficient design information including proposed parameter settings to allow critical assessment including analytical modelling of the effect of the new or replacement *equipment* on the performance of the *power system*.

(b) The *Network Service Provider* must:

(1) consult with other *Users* and *System Management* as appropriate; and

(2) within 20 *business day*s 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 day*s that it either accepts or disagrees with the alternative parameter settings suggested by the *Network Service Provider*.

(d) The *Network Service Provider* and the *User* must negotiate parameter settings that are acceptable to them both and if there is any unresolved disagreement between them, the matter must be determined by means of the disputes procedure provided for in clause 1.7.

(e) The *User* and the *Network Service Provider* must co-operate with each other to ensure that adequate grading of *protection* is achieved so that faults within the *User's facility* are cleared without adverse effects on the *power system*.

4.2.4 Commissioning Program

(a) Not less than 65 *business day*s (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 day*s 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 *change*s in the interest of maintaining *power system security*, safety or *quality of supply*.

(c) If the *Network Service Provider* requires *change*s, then the *Network Service Provider* and the *User* must co-operate to reach agreement and finalise the commissioning program within a reasonable period.

(d) A *User* must not commence the commissioning until the commissioning program has been finalised and the *Network Service Provider* must not unreasonably delay finalising a commissioning program.

4.2.5 Commissioning Tests

(a) The *Network Service Provider* and *System Management* 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 qualified in a relevant discipline.

(c) The *Network Service Provider* must, within a reasonable period of receiving advice of commissioning tests of a *User's* new or replacement *equipment* under this clause 4.2.5, advise the *User* whether or not it:

(1) wishes to witness the commissioning tests; and

(2) agrees with the proposed commissioning times.

(d) A *User* whose new or replacement *equipment* is tested under this clause 4.2.5 must, as soon as practicable after the completion of the relevant tests, submit to the *Network Service Provider* the commissioning test results demonstrating that a new or replacement item of *equipment* complies with these *Rules* or the relevant *access contract* or both to the satisfaction of the *Network Service Provider*.

(e) If the commissioning tests conducted under this clause 4.2.5 in relation to a *User's* new or replacement item of *equipment* demonstrate non-compliance with one or more requirements of these *Rules* or the relevant *access contract*, then the *User* must promptly meet with the *Network Service Provider* to agree on a process aimed at achieving compliance with the relevant item in these *Rules*.

(f) The *Network Service Provider* may direct that the commissioning and subsequent *connection* of a *User's equipment* must not proceed if the relevant *equipment* does not meet the technical requirements specified in clause 4.2.

(g) All commissioning tests under this clause 4.2.5 must be carried out under the supervision of personnel experienced in the commissioning of *power system primary equipment* and *secondary equipment*.

4.2.6 Coordination of Protection Settings

(a) A *User* must ensure that its *protection* settings coordinate with the existing *protection* settings of the *transmission and distribution system*. Where this is not possible, the *User* may propose revised *protection* settings, for the *transmission and distribution system* to the *Network Services Provider*. In extreme situations it may be necessary for a *User* to propose a commercial arrangement to the *Network Service Provider* to modify the *transmission or distribution system protection*. The *Network Service Provider* must consider all such proposals but it must not approve a *User's protection system* until *protection* coordination

problems have been resolved. In some situations, the *User* may be required to revise the *Network Service Provider* settings or upgrade the *Network Service Provider* 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 clause 3 of these *Rules*, or the *power system* not to comply with the performance standards specified in clause 2.2, or the *Network Service Provider* or some other *User* not to comply with their own *protection* requirements specified in the respective clauses 2.9 and 3.5, or the *power transfer capability* of the *transmission or distribution system* to be reduced.

(c) If the *Network Services Provider* reasonably determines that a setting of a *User's* control system or *protection system* needs to change in order for the *User* to comply with the requirements of clause 3 of these *Rules*, or for the *power system* to meet the performance standards specified in clause 2.2, or so as not to cause the *Network Service Provider* or some other *User* to fail to comply with its own *protection* requirements specified in clause 2.9 or 3.5, as applicable, or for the *power transfer capability* of the *transmission or distribution system* to be restored, the *Network Service Provider* must consult with the *User* and may direct in writing that a setting be applied in accordance with the determination.

(d) The *Network Service Provider* may require a test in accordance with clause 4.1.3 to verify the performance of the *User's* equipment with any new setting.

4.2.7 Approval of Proposed Protection

(a) A *User* must not allow its plant to take supply of electricity from the *power system* without prior approval of the *Network Service Provider*.

(b) A *User* must not change the approved *protection* design or settings without prior written approval of the *Network Service Provider.*

4.3 *DISCONNECTION* AND *RECONNECTION*

4.3.1 General

(a) If the *Network Service Provider*, in its opinion, needs to interrupt *supply* to any *User* of the *transmission system* for reasons of safety to the public, the *Network Service Provider's* personnel, any *Users' equipment* or the *Network Service Provider's equipment*, the *Network Service Provider* must (time permitting) consult with the relevant *User* prior to executing that interruption. Such consultations are generally impracticable at the *distribution system* level, because of the large number of *Customers* involved, and hence are not required in relation to interruptions to *supply* to *Customers* on the *distribution system*.

(b) The *Network Service Provider* may *disconnect Users* if the *transmission or distribution system* is operating outside the permissible limits.

4.3.2 Voluntary *Disconnection*

(a) Unless agreed otherwise and specified in an *access contract*, 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 *access contract*, 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

(a) If a *User's facility* is to be *disconnected* permanently from the *power system*, whether in accordance with clause 4.3.2 or otherwise, the *Network Service Provider* and the *User* must, prior to such *disconnection* occurring, follow agreed procedures for *disconnection*.

(b) The *Network Service Provider* must notify other *Users* if it reasonably believes that their rights under an *access contract* 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 *access contracts* that may be required.

(c) Any *disconnection* procedures agreed to or determined under clause 4.3.3(a) must be followed by the *Network Service Provider* and all relevant *Users*.

4.3.4 Involuntary *Disconnection*

(a) The *Network Service Provider* or *System Management* may *disconnect* a *User's facilities* from the *transmission or distribution system* or otherwise curtail the provision of services in respect of a *connection point*:

(1) in the case of the *Network Service Provider*, where directed to do so by *System Management* or the *Independent Market Operator* in the exercise or purported exercise of a power under the Wholesale Electricity Market Rules;

(2) in accordance with clause 4.1.3(f);

(3) in accordance with clause 4.3.5;

(4) during an emergency in accordance with clause 4.3.6; or

(5) in accordance with the *User's access contract*.

(b) In all cases of *disconnection* by the *Network Service Provider* during an emergency in accordance with clause 4.3.5, the *Network Service Provider* must provide a report to the *User* advising of the circumstances requiring such action.

4.3.5 Curtailment to Undertake Works

(a) The *Network Service Provider* may, in accordance with *good electricity industry practice*, *disconnect* a *User's facilities* from the *transmission or distribution system* or otherwise curtail the provision of services in respect of a *connection point* (collectively in this clause 4.3.5 a "curtailment"):

(1) to carry out planned *augmentation* or maintenance to the *transmission or distribution system*; or

(2) to carry out unplanned maintenance to the *transmission or distribution system* where *the Network Service Provider* considers it necessary to do so to avoid injury to any person or material damage to any property or the environment; or

(3) if there is a breakdown of, or damage to, the *transmission or distribution system* that affects *the Network Service Provider's* ability to provide services at that *connection point*; or

(4) if an event:

(A) that is outside the reasonable control of the *Network Service Provider*; and

(B) whose effect on the assets of the *Network Service Provider* or the property of any person can not, by employing *good electricity industry practice*, be prevented,

is imminent, with the result that safety requirements or the need to protect the assets of the *Network Service Provider* or any other property so require; or

(5) to the extent necessary for *the Network Service Provider* to comply with a *written law*.

(b) *The Network Service Provider* must keep the extent and duration of any curtailment under clause 4.3.5(a) to the minimum reasonably required in accordance with *good electricity industry practice.*

(c) *The Network Service Provider* must notify each *User* of the *transmission system* who will or may be adversely affected by any proposed curtailment under clause 4.3.5(a) of that proposed curtailment as soon as practicable. Where it is not reasonably practicable to notify a *User* prior to the commencement of the curtailment, the *Network Service Provider* must do so as soon as reasonably practicable after its commencement.

(d) If *the Network Service Provider* notifies a *User* of a curtailment in accordance with clause 4.3.5(c) in respect of a *connection point*, the *User* (acting reasonably and prudently) must comply with any requirements set out in the notice concerning the curtailment.

4.3.6 *Disconnection* During an Emergency

Where the *Network Service Provider* or *System Management* is of the opinion that it must *disconnect* a *User's facilities* during an emergency under these *Rules* or otherwise, then the *Network Service Provider* or *System Management*, as applicable, may:

(a) request the relevant *User* to reduce the *power transfer* at the proposed point of *disconnection* to zero in an orderly manner and then *disconnect* the *User's facility* by automatic or manual means; or

(b) immediately *disconnect* the *User's facilities* by automatic or manual means where, in the opinion of the *Network Service Provider* or *System Management*, as applicable, it is not appropriate to follow the procedure set out in clause 4.3.6(a) because action is urgently required as a result of a threat to safety of persons, hazard to *equipment* or a threat to *power system security*.

4.3.7 Obligation to Reconnect

The *Network Service Provider* or *System Management* must reconnect a *User'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 Operator* in the exercise or purported exercise of a power under the Wholesale Electricity Market Rules;

(b) if the breach of the *Access Code*, these *Rules* or an *access contract* 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 Management*, as applicable, that the breach will not re-occur.

(d) .

5. *TRANSMISSION AND DISTIRBUTION SYSTEM* OPERATION AND COORDINATION

5.1 APPLICATION

This section 5 applies to the operation and coordination of the *Network Service Provider's* and *Users*' *facilities* to the extent not covered under the Wholesale Electricity Market Rules. For Market *Generators* (as defined under the Wholesale Electricity Market Rules, and generally being *Generators* the rated capacity of whose *generating system* equals or exceeds 10 MW) the rules that apply for *power system* operation and coordination are those found within the Wholesale Electricity Market Rules.

5.2 INTRODUCTION

5.2.1 Purpose and Scope of section 5

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

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

(b) to establish arrangements for the actual *dispatch* of *generating units* and *loads* by *Users*.

5.3 *POWER SYSTEM* OPERATION CO-ORDINATION RESPONSIBILITIES AND OBLIGATIONS

5.3.1 Responsibilities of the *Network Service Provider* for Operation Co-ordination of the *Power System*

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

(a) 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*;

(b) 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) assess the impacts of any technical and operational *constraint*s of all plant and equipment connected to the *transmission or distribution system* on the operation of the *power system*;

(d) subject to clause 5.3.2, to *disconnect User's equipment* as necessary during emergency situations to facilitate the re-establishment of the *normal operating state* in the *power system*;

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

(f) 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 could reasonably threaten safe and reliable operation of the network. Such situations or deficiencies include:

(1) *power system frequencies* outside those specified in the definition of *normal operating state*;

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

(3) actual or potential *power system* instability; and

(4) 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) The *Network Service Provider* must operate those parts of the *transmission and distribution system* that are not under the control of *System Management* so as to ensure that the system performance standards as specified in clause 2.2.2 are met.

5.3.3 *User* Obligations

(a) A *User* must ensure that only appropriately qualified and competent persons operate *equipment* that is directly connected to the *transmission or distribution system* through a *connection point*.

(b) A *User* must co-operate with any review of operating incidents undertaken by the *Network Service Provider* or *System Management* under clause 5.7.3.

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

(e) A *User* must notify *System Management* or, where appropriate, the *Network Service Provider,* 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 clause 3.3.5.4.

(f) Except in an emergency, a *User* must notify the *Network Service Provider* at least 5 *business day*s prior to taking a *protection* of transmission plant out of service.

(g) Except in an emergency, a *User* must notify the *Network Service Provider* at least 5 *business day*s prior to taking a *protection* of distribution plant out of service if this *protection* is required to meet a *critical fault clearance time*.

5.4 CONTROL OF *TRANSMISSION SYSTEM VOLTAGES*

5.4.1 *Transmission and Distribution System Voltage* Control

(a) The *Network Service Provider* must determine the adequacy of the capacity to produce or absorb *reactive power* in the control of the *transmission and distribution system voltages*.

(b) The *Network Service Provider* must assess and determine the limits of the operation of the *transmission and 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 its *access contracts*; and

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

(f) *Reactive power facilities* arranged under clause 5.4.1(e) may include any one or more of:

(1) *synchronous generating unit voltage control*s usually associated with *tap-changing transformers*; or *generating unit* AVR setpoint control (rotor current adjustment);

(2) *synchronous condensers* (compensators);

(3) *static VAr compensator*s (SVC);

(4) *static synchronous compensator*s (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

The *Network Service Provider* must arrange, coordinate and supervise the conduct of appropriate tests to assess the availability and adequacy of the provision of *reactive power* devices to control and maintain *power system voltages*.

5.5 *PROTECTION* OF *POWER SYSTEM EQUIPMENT*

5.5.1 *Power System* Fault Levels

(a) The *Network Service Provider* must determine the maximum prospective fault levels at all *transmission system busbars* and all *zone substation supply busbars*. This determination must consider all credible *transmission system* operating configurations and all credible *generation* patterns, but need not consider short term switching arrangements that result in, for example, the temporary paralleling of *transformers* to maintain continuity of *supply*.

(b) The fault levels determined under clause 5.5.1(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 Audit and Testing

The *Network Service Provider* must coordinate such inspections and tests as the *Network Service Provider* thinks appropriate to ensure that the *protection* of the *transmission and distribution system* is adequate to protect against damage to *power system equipment* and *equipment*. Such tests must be performed according to the requirements of clause 4.1.

5.5.3 Power Transfer Limits

The *Network Service Provider* must not exceed the power transfer limits specified in clause **Error! Reference source not found.**, 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* of one *protection* of a *transmission element*, the *Network Service Provider* must determine, and where appropriate advise *System Management* of, the most appropriate action to take to deal with that *outage*. Depending on the circumstances, the determination may be:

(1) to leave the *transmission element* in service for a limited duration;

(2) to take the *transmission element* out of service immediately;

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

(4) to accept a degraded performance from the *protection system*, with 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 Wholesale Electricity 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

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 maloperation of, any *protection* or *control system*, which could be expected to adversely effect 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

It is the responsibility of *System Management* under the Wholesale Electricity Market Rules to manage *supply* shortfall events arising from a shortage of *generation* or from multiple *contingency events* on the 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 points of *load connection* as:

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

(B) directed by *System Management* in accordance with the demand control measures in the Wholesale Electricity 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 *Customers*, then commercial *Customers* and finally industrial *Customers*.

(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 Wholesale Electricity 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 *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.

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 an *access contract*.

(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

This clause is not intended to apply to *Users* who are registered as Rule Participants under Section 2 of the Wholesale Electricity Market Rules. *Outage* planning for Rule Participants is undertaken by *System Management* in accordance with clauses 3.18 to 3.21 of the Wholesale Electricity 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*s 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*s for each of the 2 *financial year*s following the *financial year* to which the maintenance schedule provided under clause 5.8(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 connections*.

(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) Both a maintenance schedule and a maintenance plan must:

(1) specify the dates and duration of planned *outage*s for the relevant *equipment* which may have an impact on the *transmission system*;

(2) specify the work to be carried out during each such an *outage*;

(3) be in writing in substantially the form requested by the *Network Service Provider*; and

(4) be consistent with *good electricity industry practice*.

(e) If a *User* becomes aware that a maintenance schedule provided by the *User* under clause 5.8(a)(1) in respect of one of its *connection*s 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 *access contract*, agreement, 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.

5.10 *POWER SYSTEM* OPERATIONSUPPORT

5.10.1 Remote Control and Monitoring Devices

(a) All remote control, operational metering and monitoring devices and local circuits as described in section 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 Management*.

5.10.2 *Power System* Voice/Data *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*. The requirements which 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) Where required by *System Management* or the *Network Service Provider:*

(1) *A User* must provide, for each *facility*, two independent telephone communication systems fully compatible with the *equipment* installed at the appropriate *control centre* nominated by the *Network Service Provider*.

(2) A *User* must maintain both telephone communication systems 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.

(3) A *User* must establish and maintain a form of electronic mail facility as approved by the *Network Service Provider* for communication purposes.

(c) 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*.

(d) Contact details to be provided by the *Network Service Provider* in accordance with clause 5.10.2.(c) include position, telephone numbers, a facsimile number and an electronic mail address.

5.10.3 Authority of nominated operational contacts

The *Network Service Provider* and a *User* are each entitled to rely upon any communications given by or to a contact designated under clause 5.10.2 as having been given by or to the *User* or the *Network Service Provider*, as the case requires.

5.10.4 Records of *Power system Operational communication*

(a) The *Network Service Provider* and *Users* must log each telephone *operational communication* in the form of entries in a log book which provides a permanent record as soon as practicable after making or receiving the *operational communication*.

(b) In addition to the log book entry required under clause 5.10.4(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 5.10.4(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 *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 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 nomenclature 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 nomenclature.

(d) The *Network Service Provider* may, by notice in writing, require a *User* to *change* the existing numbering or nomenclature of *transmission* and *distribution equipment* and apparatus of the *User* for purposes of uniformity.

ATTACHMENT 1 - GLOSSARY

In these *Rules*:

(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 clauses 2.9 and 3.5, 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 outage*s; 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 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 Arrangement	The *Access Arrangement* for the *SWIS* approved by the Economic Regulation Authority on [ ].
access services	The same meaning as "covered service" in the *Access Code*.
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 watthours (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 an *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.
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 *access contract*.
ancillary service(s)	The same meaning as "covered service(s)" in the *Access Code*.
applicant	A person (who may be a *User*) who has lodged an access application for the transmission and distribution systems to establish or modify an *access contract*, and includes a prospective *applicant*.
augment, augmentation	The meaning given in the *Access Code*.
***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 scheme* or *backup protection system	A *protection* scheme or *protection system* intended to supplement the main *protection system* in case the latter must be ineffective, 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*.

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*.
breaker fail	In relation to a *protection scheme*, that part of the *protection scheme* that protects a *User's facilities* against the non-operation of a circuit breaker that is required to open.
busbar	A common *connection point* in a *power station substation* or a *transmission* or *distribution system substation*.
business day	The meaning given in the *Access Code*.
capacitor bank	A type of electrical *equipment* used to generate *reactive power* and therefore support *voltage* levels on *transmission* or *distribution* lines.
cascading outage	The occurrence of an uncontrollable succession of *outage*s, each of which is initiated by conditions (e.g. instability or overloading) arising or made worse as a result of the event preceding it.
change	Includes amendment, alteration, addition or deletion.
circuit breaker failure	A circuit breaker will be deemed to have failed if, having received a trip signal from a *protection scheme*, it fails to interrupt fault current within its design operating time.
commitment	The commencement of the process of starting up and synchronising a *generating unit* to the *power system*.
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	The physical link between a *User* and the *Network Service Provider* (by means of a *connection asset*) that allows the transfer of electricity from one to the other.
connection asset	The *equipment* that allows the transfer of electricity between the electricity *transmission* or *distribution system* and an electrical system that is not part of that *transmission or distribution system*. This includes any *transformer*s or switchgear at the point of *interconnection* (including those that operate at a nominal *voltage* of less than 66 kV) but does not include the lines and switchgear at the *connection* that form part of the electricity *transmission* or *distribution system*.

connection point	The agreed point of *supply* established between the *Network Service Provider* and a *User*.
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	A limitation on the capability of a *transmission or distribution system*, *load* or a *generating unit* preventing it from either transferring, consuming or generating the level of electric power which would otherwise be available if the limitation was removed.
Consumer	A *User* who consumes electricity supplied through a *connection point*.
contingency event	An event affecting the *power system* which the *Network Service Provider* expects would be likely to involve the failure or removal from operational service of a *generating unit* or *transmission*/*distribution* element.
control centre	The *facility* used by the *Network Service Provider* for directing the minute to minute operation of the *power system*.
controllable	for the purpose of clause 2.2.11, means 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.
controller	The same meaning as "designated *controller*" in Appendix 3 of the *Access Code*.
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*.
converter coupled generating unit	A *generating unit* that uses *equipment* that *change*s 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 contingency event	A single *contingency event* or the type specified in clause 2.3.7.1(a).

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* or *distribution* line or other item of *equipment* that forms part of a *power system*.
***current transformer* (*CT*)**	A *transformer* for use with meters or *protection* devices or both in which the current in the secondary winding is, within prescribed error limits, proportional to and in phase with the current in the primary winding.
Customer	A purchaser of electricity supplied through a *transmission or distribution system*.
damping ratio	A standard mathematical parameter that characterises the shape of a damped sine wave.
day	Unless otherwise specified, the 24 hour period beginning and ending at midnight Western Standard Time (WST).
decommission	The act of causing a *generating unit* to cease to generating indefinitely and *disconnect*ing it from a *transmission or distribution system*.
differing principle	Two *protection*s are of *differing principle* if their functioning is based on different measurement or operating methods, or if they use similar principles but have been designed and manufactured by different organisations.
direction	A *direction* issued by the *Network Service Provider* or *System Management* to any *User* requiring the *User* to do any act or thing which the *Network Service Provider* or *System Management* 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 unit	A *generating unit* that, in its satisfactory normal operating state, is capable of closely controlling its real power output.
dispatch	The act of the *Network Service Provider* in committing to service all or part of the *generation* available from a *generating unit*.

distribution	The functions performed by a *distribution system*, including conveying, transferring or permitting the passage of electricity.
distribution feeder	A high voltage radial circuit forming part of the *distribution system* that is supplied from a *zone substation*.
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 System*.
dynamic performance	The response and behaviour of networks and *facilities* which are *connected* to the networks when the *normal operating state* of the *power system* is disturbed.
embedded generating unit	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*.
emergency conditions	The operating conditions applying after a significant *transmission system* element has been removed from service other than in a planned manner.
energisation	The act or process of operating switching *equipment* or starting up *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	Act*ive 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.
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*; (b) a *substation*; (c) *equipment* by which electricity is consumed; and (d) a *control centre*.
fault clearance time	The time interval between the occurrence of a fault and the fault clearance.
financial year	A period or 12 *months* commencing on 1 July.
frequency	For alternating current electricity, the number of cycles occurring in each second, measured in Hz.
frequency operating standards	The standards which specify the *frequency* levels for the operation of the *power system* set out clause 2.2.
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.
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*.
Generator	A *User* who owns, controls or operates a *generating system* that supplies electricity to, or who otherwise supplies electricity to, a *transmission system* or *distribution system*.
generator machine	the machine used for the generation of electricity, excluding related or auxiliary *equipment*.

good electricity industry practice	The meaning given in the *Access Code*.
halving time	The elapsed time required for the magnitude of a damped sine wave to reach half its initial value.
high voltage	Any nominal *voltage* above 1 kV.
Independent Market Operator	The entity authorised under the *Electricity Industry (Wholesale Electricity Market) Regulations 2004* (WA) to administer and operate the Western Australia Wholesale Electricity Market.
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.
interconnection	A *transmission line* or group of *transmission lines* that connects the *transmission system*s in adjacent *regions*.
inverter coupled generating unit	A *generating unit* which uses a machine, device, or system that *change*s its direct-current power to alternating-current power acceptable for *power system connection*.
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 system*s. *Large disturbance* is typically caused by a short circuit on a nearby *power system* component (for example, *transmission line*, *transformer*, etc).
load	Either: (a) a *connection point* at which electric power is made available to a person; or (b) the amount of electric power made available at a defined instant at a *connection point*, as the case requires.
load shedding	Reducing or *disconnecting load* from the *power system*.
low voltage	Any nominal *voltage* of 1 kV and below

main protection scheme	A *protection scheme* that has the primary purpose of disconnecting specific *equipment* from the *transmission and distribution system* in the event of a fault occurring within that *equipment*.
main protection system	A *protection system* that has the primary purpose of disconnecting specific *equipment* from the *transmission and distribution system* in the event of a fault occurring within that *equipment*.
maintenance conditions	The operating conditions that exist when a significant element of the *transmission system* or the *distribution system* has been taken out of service in a planned manner so that maintenance can be carried out safely.
maximum fault current	The current that will flow to a fault on an item of *equipment* when *maximum system conditions* prevail.
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*.
minimum fault current	The current that will flow to a fault on an item of *equipment* when *minimum system conditions* prevail.
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.
Network Service Provider	The meaning given to it in clause 1.3(a).

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 5.11.
non-dispatchable generating unit	A *generating unit* that in its satisfactory normal operating state is not capable of closely controlling its real power output.
normal operating state	Characterises operation when all significant elements of a *transmission system* are in service and operation is within the secure *technical envelope*.
operational communication	A communication concerning the arrangements for, or actual operation of, the *power system* in accordance with the *Rules*.
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* Zone**	The meaning given in the *Access Code*.
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 System* and its associated *generation* and *transmission and distribution systems*, 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 5.9.1.

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 *System Management*.
power system stability	The ability of an electric *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.
primary equipment	Refers to apparatus which conducts *power system load* or conveys *power system voltage*.
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.
protection system	A system which includes all the *protection schemes* designed to disconnect faulted *primary equipment* from the *transmission or distribution system* 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, unless otherwise stated in these *Rules* or an *access contract*.
reactive energy	A measure, in VArhours (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 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).

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 *transformer*s 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 unit*s or synchronous compensators, and *staticVAr 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 an *access contract*.
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.
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	A measure of the probability of *equipment* performing its function adequately for the period of time intended, under the operating conditions encountered.

reliable	The expression of a recognised degree of confidence in the certainty of an event or action occurring when expected.
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*).
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.
rotor angle stability	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.
RTU	A remote terminal unit installed within a *substation* to enable monitoring and control of *equipment* from a remote *control centre*.
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 the *Network Service Provider* 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	A *generating unit* which is *dispatch*ed by the *Network Service Provider*.

secondary equipment	*Equipment* within a *facility* or the electricity *transmission or distribution system*s 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*.
security	The security of a *power system* is the degree of risk in its ability to survive imminent disturbances (contingencies) without interruption of *Customer* service. 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.
sensitivity	In relation to *protection schemes*, has the meaning in clause 2.9.6.
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 *change*s, *generating unit* AVR setpoint *change*s, changes in the connected load, etc.
small-disturbance rotor angle stability	Is the ability of the power system to maintain *synchronism* under *small disturbances*.
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 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 System or ***SWIS***	The *transmission system* in South West of the state of Western Australia, extending from Geraldton to Albany areas and across to the Eastern Goldfields, as defined in the *Act*.
spare capacity	Any portion of firm capacity or non-firm capacity not committed to existing *Users*.

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.
staticVAr compensator	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	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.*
substation	A *facility* at which lines are switched for operational purposes, and which may include one or more *transformer*s so that some *connected* lines operate at different nominal *voltages* to others.
supply	The delivery of electricity as defined in the *Act*.
supply transformer	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*.
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 customers, *disconnection* of *transmission lines*, possible damage to synchronous machines and system shutdown.
synchronous condenser	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 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*.

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 state*.
System Management	The ring fenced business unit of Western Power, or one of its successor organisations, that is responsible for the functions set out in clauses 2.2.1 and 2.2.2 of the Wholesale Electricity 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 Wholesale Electricity Market Rules.
technical minimum	The minimum continuous active power output of a *generating unit*.
terminal station	A substation that transforms electricity between two *transmission system voltages* and which supplies electricity to *zone substations* but which 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.
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 element	A single identifiable major component of a *transmission system* involving: (a) an individual *transmission* circuit or a phase of that circuit; (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 line* or an associated *substation*, which may include *transformer*s, circuit breakers, *reactive equipment* and *monitoring equipment* and control *equipment*.
transmission line	A power line that is part of a *transmission system*.
transmission or distribution system	Either the *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 transmission of electricity at nominal voltages of 66 kV or higher, and which forms part of the South West Interconnected System.
transmission system planning criteria	The criteria prepared by the *Network Service Provider* under section A6.1(m) of the *Access Code*.
trip circuit supervision	A function incorporated within a *protection* that results in alarming for loss of integrity of the *protection*'s trip circuit. *Trip circuit supervision* supervises a *protection*'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* 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 protections schemes of differing principle	Are *protection schemes* having *differing principle*s of operation and which, in combination, provide dependable clearance of faults on that *equipment* 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* would need to have its own independent battery and battery charger system *supply*ing all that *protection*'s trip functions.
User	Has the meaning given in clause 1.3(b)(3).
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 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) and available from Internet site http://www.energysafety.wa.gov.au/
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 form the context, and subject to the *Act* and the *Access Code*, these *Rules* must be interpreted in accordance with the following rules of interpretation:

(a) a reference in these *Rules* to a contract or another instrument includes a reference to any amendment, variation or replacement of it save for a reference to an *Australian Standard* that explicitly states a date or year of publication;

(b) a reference to a person includes a reference to the person's executors, administrators, successors, substitutes (including persons taking by novation) and assigns;

(c) references to time are to Western Standard Time, being the time at the 120th meridian of longitude east of Greenwich in England, or Coordinated Universal Time, as required by the *National Measurement Act 1960* (Cth);

(d) any calculation must be performed to the accuracy, in terms of a number of decimal places, determined by the *Network Service Provider* in respect of all *Users*;

(e) where any word or phrase is given a defined meaning, any part of speech or other grammatical form of that word or phrase has a corresponding meaning;

(f) the word "including" means "including, but without limiting the generality of the foregoing" and other forms of the verb "to include" are to be construed accordingly;

(g) a *connection* is a *User's connection* or a *connection* of a *User* if it is the subject of an *access contract* between the *User* and the *Network Service Provider*;

(h) a reference to a half hour is a reference to a 30 minute period ending on the hour or on the half hour and, when identified by a time, means the 30 minute period ending at that time; and

(i) measurements of physical quantities are in Australian legal units of measurement within the meaning of the *National Measurement Act 1960* (Cth).

ATTACHMENT 3 - SUMMARY OF SCHEDULES OF TECHNICAL DETAILS TO SUPPORT APPLICATION FOR *CONNECTION* AND *ACCESS CONTRACT*

A3.1. Various sections of the Code require that *Users* submit technical data to the *Network Service Provider*. This Attachment 3 summarises schedules which list the typical range of data which 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 access application*, and will form part of the technical specification in the *access contract*.

A3.2. Data is coded in categories, 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 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*, to allow the *Network Service Provider* to prepare an offer of terms for an *access contract* and to assess the requirement for, and effect of, *transmission system augmentation* or *extension* options. Such data is normally limited to the items denoted as Standard Planning Data (S) in the technical data schedules S1 to S5.

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*.

Registered system planning data

This is the class of data which will be included in the *access contract* 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*.

Registered data

Registered Data consists of data validated and *augment*ed prior to actual *connection* a 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 items which 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 *User* may *change* any data item at a time other than when that item would normally be reviewed or updated by

submission to the *Network Service Provider* of the revised data, together with authentication documents, egotist reports.

A3.4. Schedules S1 to S5, which are given in Attachment 4 to Attachment 9, cover the following data areas:

(a) Schedule S1 - *Generating unit* Design Data. This comprises *generating unit* fixed design parameters.

(b) Schedule S2 - *Generating unit* Setting Data. This comprises settings which can be varied by agreement or by *direction* of the *Network Service Provider*.

(c) Schedule S3 - *Transmission system* and e*quipment* Technical Data. This comprises fixed electrical parameters.

(d) Schedule S4 - *Transmission* e*quipment* and Apparatus Setting Data. This comprises settings which can be varied by agreement or by *direction* of the *Network Service Provider*.

(e) Schedule S5 - *Load* Characteristics. This comprises the estimated parameters of *load* groups in respect of, for example, harmonic content and response to *frequency* and *voltage* variations.

A3.5. A *Generator* that connects a *generating unit* that is not a *synchronous generating unit* must be given exemption from complying with those parts of schedules S1 and S2 that are determined by the *Network Service Provider* to be not relevant to such *generating units*, but must comply with those parts of Schedules S3, S4, and S5 that are relevant to such *generating units*, as determined by the *Network Service Provider*. For this non-*synchronous generating unit*, 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 - SCHEDULE S1 - *GENERATING UNIT* DESIGN DATA

Symbol	Data Description	Units	Data Category
	***Power station* technical data:**		
	Connection point to *Transmission system*	Text, diagram	S, D
	Nominal *voltage* at *connection* to *Transmission system*	kV	S
	Total Station Net Maximum Capacity (NMC)	MW (sent out)	S, D, R2
	At *connection point*:		
	· Maximum 3 phase short circuit infeed calculated by method of *AS* 3851 (1991) (Amndt 1-1992)		
	· Symmetrical	kA	S, D
	· Asymmetrical	kA	D
	· Minimum zero sequence impedance	(a+jb)% on 100 MVA base	D
	· Minimum negative sequence impedance	(a+jb)% on 100 MVA base	D
	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
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)% on MVA base	

***Generating unit* resistance:**

RA	·	Stator Resistance	% on MBASE	S, D, R1, R2
RF	·	Rotor resistance at 20°C	ohms	D, R1

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	Graphical data	D, R1, R2
GOCC	Open Circuit Characteristic	Graphical data	R1
GSCC	Short Circuit Characteristic	Graphical data	R1
GZPC	Zero *power factor* curve	Graphical data	R1
	V curves	Graphical data	R1
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 capability at rated MW, terminal *voltage* and speed	MVAr (for time)	D, R1, R2
	Leading *Reactive power* at rated MW	MVAr import	S,D, R2
	***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 Excitation Limiter (drawn on capability *generating unit* diagram)	Text/ Block diagram	D, R2
Dynamic Characteristics of Under Excitation Limiter (drawn on capability *generating unit* diagram)	Text/ 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* Deadband	Hz	D, R1
	Minimum *Frequency* Deadband	Hz	D, R1
	MW Deadband	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 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 eg for co*generation equipment*)	Seconds	D
	MW output versus turbine speed (47-52 Hz)	Diagram	D, R1, R2
	Type of turbine (heavy industrial, aero derivative etc)	Text	S
	Number of shafts		S,D
	Gearbox Ratio		D

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*		
	Windfarm/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
	Long-term flicker factor for *generating unit*		S, D, R1
	Long term flicker factor for windfarm		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 windspeed	Diagram	D
	Spatial Arrangement of windfarm	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

Symbol	**Data description**	**Units**	**Data category**
	Curves showing torque, *power factor*, efficiency, stator current, MW output versus slip (+ and -).	Graphical data	D,R1,R2
	Number of *capacitor bank*s 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*

ATTACHMENT 5 - SUBMISSION REQUIREMENTS FOR ELECTRICAL PLANT PROTECTION

TRANSMISSION ACCESS CODE DOCUMENT SUBMITTAL REQUIREMENTS FOR ELECTRICAL PLANT PROTECTION		
DATA SUBMISSION CODES (ALL REGISTERED DATA, ie AFTER SIGNING OF THE ACCESS AGREEMENT):		
D	As defined in Attachment 3: to be agreed in the access agreement.	
R1	As defined in Attachment 3: to be agreed in the access agreement.	
R2	**As defined in Attachment 3: to be agreed in the access agreement.**	
Item	**Description**	**Sumbission Code**
PROTECTION DESIGN PHILOSOPHY DOCUMENT:		
1	Documentation explaining the general protection philosophy. To include: - Present and design minimum and maximum fault levels. - Present and design minimum and maximum fault contributions to the network from the user, at the point of connection. - 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 (ie islanding or load shedding schemes) - Protection number 1 philosophy - Protection number 2 philosophy	D, R1 and R2
2	Power single line diagram, down to and including the low voltage (greater than 50V AC) bus(s). To include: - Voltage levels, and - Transformer ratings, winding configurations and earthing connections - Generator ratings and earthing connections - Operating status of switching devices - Earthing configuration - Primary plant interlocks	D, R1 & R2
3	Details of protection interfaces between the Transmission Network and the User.	D, R1 & R2
4	Protection single line diagram, down to and including the low voltage (greater than 50V AC) bus(s). To include: - Current transformer locations, rated primary and secondary current, rated short-time thermal current, rated output, accuracy class and designation. - Voltage Transformer locations, winding connections, rated primary and secondary voltages, rated output and accuracy class. - Relay make and model number - Relay functions employed - Primary plant mechanical protections - Trip details (diagramatic or by trip matrix)	R1 & R2
5	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 (C) to include tested values of generator and transformer impedances (ie from manufacturers test certificates)	R1 & R2
6	Tripping and control power supply (eg DC system) single line diagram.	R1 & R2
7	Power flow details at point of connection as per the data requested in Schedule S5.	R1 & R2
8	HV circuit breaker details: - A control and protection schematic diagram of the circuit breaker(s) at the user connection to the transmission network. - Type, rated current and rated fault MVA or rated breaking current of all HV circuit breakers	R1 & R2
9	HV switch fuse details: - Rated current of fuse - Rated breaking current of fuse - Type of fuse - Current-time characteristic curves	R1 & R2
PROTECTION SETTINGS PHILOSOPHY DOCUMENT:		
10	General settings philosophy	R1 & R2
11	Calculated critical fault clearance times	R1 & R2
12	Protection function settings to be employed and reasons for selecting these settings. Diagrams are to be submitted where applicable.	R1 & R2
13	Overcurrent grading curves for phase faults.	R1 & R2
14	Overcurrent grading curves for earth faults.	R1 & R2

ATTACHMENT 6 - SCHEDULE S2 - *GENERATING UNIT* SETTING DATA

Description Category	**Units**	**Data**
***Protection* Data:**		
Settings of the following *protection*s:		
Loss of field	Text	D
Under excitation	Text, diagram	D
Over excitation	Text, diagram	D
Differential	Text	D
Under *frequency*	Text	D
Over *frequency*	Text	D
Negative sequence component	Text	D
Stator over*voltage*	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 PSS/E): The source code of the model must also be provided, in accordance with clause 3.3.9.	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 PSS/E).The source code of the model must also be provided, in accordance with clause 3.3.9.		

	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 - SCHEDULE S3 *TRANSMISSION SYSTEM* AND *EQUIPMENT* TECHNICAL DATA OF *EQUIPMENT* AT OR NEAR *CONNECTION POINT*

Description	Units	Data Category
***Voltage* Rating**		
Nominal *voltage*	kV	S, D
Highest *voltage*	kV	D
Insulation Co-ordination		
Rated lightning impulse withstand *voltage*	kVp	D
Rated short duration power *frequency* withstand *voltage*	kV	D
Rated Currents		
Circuit maximum current	kA	S, D
Rated Short Time Withstand Current	kA for seconds	D
Ambient conditions under which above current applies	Text	S,D
Earthing		
System Earthing Method	Text	S, D
Earth grid rated current	kA for seconds	D
Insulation Pollution Performance		
Minimum total creepage	mm	D
Pollution level	Level of IEC 815	D
Controls		
Remote control and data transmission arrangements	Text	D
***Transmission system* Configuration**		
Operation Diagrams showing the electrical circuits of the existing and proposed main *facilities* within the *User's* ownership including *busbar* arrangements, phasing arrangements, earthing arrangements, switching *facilities* and operating *voltages*.	Single line Diagrams	S, D, R1

***Transmission system* Impedances**

For each item of *equipment* (including lines): details of the positive, negative and zero sequence series and shunt impedances, including mutual coupling between physically adjacent elements.	% on 100 MVA base	S, D, R1

Short Circuit Infeed to the *Transmission system*

Maximum *Generating unit* 3-phase short circuit infeed including infeeds from *generating units connected* to the *User's* system, calculated by method of *AS* 3851 (1991)(Amndt 1-1992).	kA symmetrical	S, D, R1
The total infeed at the instant of fault (including contribution of induction motors).	kA	D, R1

Description	**Units**	**Data Category**
Minimum zero sequence impedance of *User's transmission system* at *connection point*.	% on 100 MVA base	D, R1
Minimum negative sequence impedance of *User's transmission system* at *connection point*.	% on 100 MVA base	D, R1

***Load* Transfer Capability:**

Where a *load*, or group of *loads*, may be fed from alternative *connection points*:		
Load normally taken from *connection point* X	MW	D, R1
Load normally taken from *connection point* Y	MW	D, R1
Arrangements for transfer under planned or fault *outage* conditions	Text	D

Circuits Connecting *Embedded generating units* to the *Transmission system*:

For all *generating units*, all connecting lines/cables, *transformer*s 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		
***Transformer*s at *connection point*s:**		
Saturation curve	Diagram	R

ATTACHMENT 8 - SCHEDULE S4 - *TRANSMISSION SYSTEM EQUIPMENT* AND APPARATUS SETTING DATA

Description	Units	Data Category
***Protection* Data for *Protection* relevant to**		
***Connection point*:**		
Reach of all *protection*s on *transmission* lines, or cables	ohms or % on 100 MVA base	S, D
Number of *protection*s on each item	Text	S, D
Total fault clearing times for near and remote faults	ms	S, D, R1
Line reclosure sequence details	Text	S, D, R1
Tap *Change* Control Data:		
Time delay settings of all *transformer* tap *change*rs.	Seconds	D, R1
Reactive Compensation (including filter banks):		
Location and Rating of individual shunt *reactors*	MVAr	D, R1
Location and Rating of individual shunt *capacitor bank*s	MVAr	D, R1
Capacitor bank capacitance	microfarads	D
Inductance of switching *reactor* (if fitted)	millihenries	D
Resistance of capacitor plus *reactor*	Ohms	D
Details of special controls (e.g. Point-on-wave switching)	Text	D
For each *shunt reactor* or *capacitor bank* (including filter banks):		
Method of switching	Text	S
Details of automatic control logic such that operating characteristics can be determined	Text	D, R1
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 - SCHEDULE S5 - *LOAD* CHARACTERISTICS AT *CONNECTION POINT*

Data Description	**Units**	**Data Category**
For all Types of *Load*		
Type of *Load* eg controlled rectifiers or large motor drives	Text	S
Rated capacity	MW, MVA	S
Voltage level	kV	S
Rated current	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 - TEST SCHEDULE FOR SPECIFIC PERFORMANCE VERIFICATION AND MODEL VALIDATION

A9.1 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.

A9.2 Recorder *Equipment*

Digital Recorder

Signals which are to be digitally recorded and processed 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 20 seconds unless specified otherwise.

(c) recordings in ASCII format in either a 3½" floppy disc or zip disc readable on IBM or IBM compatible computer.

(d) departure from linearity of no more than 0.1% in the slope of normalised output versus input. Normalised means value/full range value.

(e) DC offset errors not greater than 0.05% of full scale in the analogue circuitry.

(f) 20 - 30 recording channels are required

Chart Recorder

Signals which are to be recorded on charts require:

(a) a chart speed of at least 20mm/sec

(b) at least 10 second recording period

(c) at least 30mm in deviation of quantities

(d) compliance with (d) & (f) of requirements for Digital Recorder

Tape Recorder

Signals which are to be recorded on Tape require :

(a) analogue to digital transcription for analogue recordings **or** transcription to multiple chart recordings which are properly annotated.

(b) production of digital data in ASCII format on either a 31/2" floppy disc or zip disc.

(c) compliance with (d) & (f) of requirements for Digital Recorder.

A9.3 *Frequency* response

(a) Where digital or chart recordings of power *frequency* waveforms are to be made a minimum bandwidth of DC - 10kHz is desirable (0dB at DC, -3dB at 10kHz).Suitable filtering is required to eliminate aliasing errors.

(b) For relatively slowly changing signals (such as main exciter quantities, transducers for MW output etc) a recording device bandwidth of DC - 100Hz is desirable, the minimum acceptable bandwidth being DC - 10Hz.

A9.4 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.

A9.5 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 (eg meter readings).

(e) data in ASCII format.

(f) SCADA type printout showing the *power system* configuration at the start of, end of, and any other appropriate time during the test sequence.

(g) other relevant data logger printout (from other than those recorders referred to in section A9.2).

A9.6 Test Preparation And Presentation of Test Results

Information/data prior to tests

(a) a detailed schedule of tests agreed by the *Network Service Provider*. The schedule must list the tests, when each test is to occur and whose responsibility it will be to perform the test.

(b) Schematics of *equipment* and subnetworks plus descriptive material necessary to draw up/agree upon a schedule of tests

(c) Most up to date relevant technical data and parameter settings of *equipment* as specified in Attachment 4 to Attachment 9.

Test Notification

(a) A minimum of 15 *business day* prior notice of test commencement must be given to the *Network Service Provider* for the purpose of arranging witnessing of tests.

(b) the *Network Service Provider's representative* must be consulted about proposed test schedules, be kept informed about the current state of the testing program, and give permission to proceed before each test is carried out.

(c) Unless agreed otherwise, tests must be conducted consecutively.

Test Results

(a) Test result data must be presented to the *Network Service Provider* within 10 *business day*s of completion of each test or test series.

(b) Where test results are not favourable it will be necessary to rectify problem(s) and repeat tests.

A9.7 Quantities to be Measured

(a) Wherever appropriate and applicable for the tests, the following quantities must be measured on the machine under test:

***Generating unit* and Excitation System**

- 3 stator L-N terminal *voltages*
- 3 stator terminal currents
- Act*ive 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 setpoint

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

(a) the *Network Service Provider* will 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.

(b) Additional test quantities may be requested and advised by the *Network Service Provider* if other special tests are necessary.

(c) Key quantities such as stator terminal *voltages*, currents, *active power* and *reactive power* of other *generating units connected* on the same bus and also *interconnection* lines with the *Network Service Provider transmission system* (from control room readings) before and after each test must also be provided.

SCHEDULE OF TESTS

Table A9.1 - Schedule of tests

	TEST DESCRIPTION		
Test No	General Description	*Change*s Applied	Test Conditions
C1	Step *change* to AVR *voltage* reference with the *generating unit* on open circuit	(a) +2.5 % (b) -2.5 % (c) +5.0 % (d) -5.0 %	• nominal stator terminal volts
C2A	Step *change* to AVR *voltage* reference with the *generating unit connected* to the system. (with the *Power system* Stabiliser out of service) *Generating unit* output levels: (i)50% rated MW, and (ii)100% rated MW	(a) +1.0 % (b) -1.0 % (c) +2.5 % (d) -2.5 % (e) +5.0 % (f) -5.0 % repeat (e) & (f) twice see note 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 *change*s must precede larger

	TEST DESCRIPTION		
Test No	General Description	*Change*s Applied	Test Conditions
			step *change*s
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
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 :	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

	TEST DESCRIPTION		
Test No	General Description	*Change*s Applied	Test Conditions
	(i) PSS in service, and (ii) PSS out of service		local *equipment* and typical electrical *connection* to the *transmission or distribution system* • *generating unit* output at 50% rated MW
C5	*load* rejection (real 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	• 100% MW output • 75% MW output

	TEST DESCRIPTION		
Test No	General Description	*Change*s Applied	Test Conditions
		slow lowering of excitation to just bring UEL into operation see notes below	• 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
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:

i. for tests C2A and C2B care must be taken not to excite large or prolonged oscillations in MW etc. Therefore, smaller step *change*s must always precede larger step *change*s to avoid such oscillations.

ii. The Figure A9.1 below shows the step *change*s referred to in the schedule of tests given above. An example is given of a +5% step to the summing junction and then a –5% step. Removal of the +5% ("-5%") step is deemed to be a –5% step.

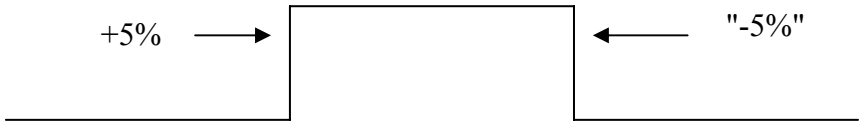


Figure A9.1 - Application of Step Signal

Unless specified otherwise the "-5%" step method shown in Figure 10.1 is used.

iii. for test C5, the instantaneous overspeed *protection* must be set at an agreed level depending on unit capability.

iv. "system" means "*power system*"

v. OR a lower step *change*, with a larger safety margin, as agreed by the *Network Service Provider*

vi. tests C1,C6, C7 and C8 need not be witnessed by the *Network Service Provider*

SPECIAL SYSTEM TESTS THAT MAY BE REQUESTED

Table A9.2 – Schedule of special system tests

Test No	TEST DESCRIPTION		
	General Description	***Change*s 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 *transformer*s on staggered taps others as determined by WPC
S4	Islanding of a subsystem consisting of *User's generating units* plus *load* with export of power by means of a link to the *Network Service Provider's* main *transmission system*.	opening of the link	• 5-10% of *generated* MW exported by means of the link • 90-95% of *generated* MW used by the subsystem's *load*
S5	AVR/OEL *change*over	*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 *change*over	*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 WPC
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 WPC
S10	Step *change* to governor/*load* reference	(a) 2.5 % step increase in MW demand signal (b) 2.5 % decrease in MW demand signal (c) equivalent of 0.05Hz subtracted from the governor speed ref. (d) 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	(a) 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	• Unsynchronised unit at rated speed and no *load*

		for about 6 sec (b) 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 (c) 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.	
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:

i. For tests S1(a) and S2 theVAr 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).

ii. For test S1(b) theVAr *load* must not allow stator terminal *voltage* to exceed 8% over*voltage* (i.e. 108% of rated value) as a result of the applied *change*.

iii. For test S1 and S2, the instantaneous over*voltage protection* must be operative and set at an agreed level greater than or equal to 10% over*voltage*.

iv. 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.

v. For test S9, care has to be taken not to excite electromechanical resonances (eg poorly damped MW swings) if the machine is on line.

vi. For the tests 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.

vii. 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 A9.2 is required.

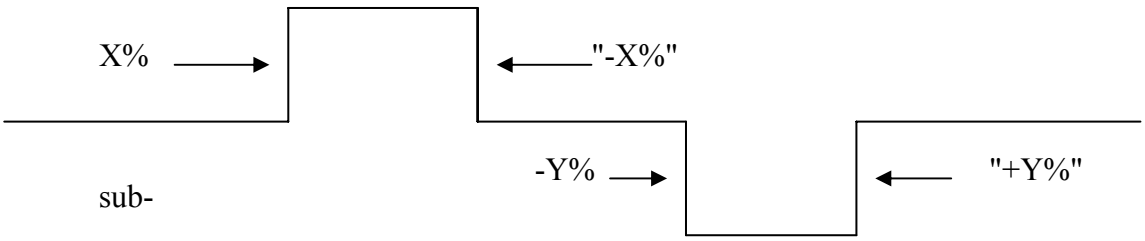


Figure A9.2 - Application of Step Signal

This page has been left blank intentionally.