DRAFT Horizon Power Technical Rules

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STAKEHOLDERS The following positions shall be consulted if an update or review is required:	
General Manager Operations	General Manager Commercial & Business Development
Manager Operations – Pilbara	Head of Power Systems
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Manager Generation	Manager Future Energy Systems

PREFACE

These *Rules* cover the *Pilbara Grid* (formerly known as the Horizon Power *North West Interconnected System*, NWIS) and Horizon Power's *Non Interconnected Systems*. They detail the technical requirements to be met by Horizon Power on the *transmission and distribution systems* and by *Users* who connect facilities to the *transmission and distribution systems*.

Users connected to the *Pilbara Grid* must comply with the *Pilbara Harmonised Technical Rules* and the requirements in these *Rules.*

*User*s of the network include Generators who access transmission and distribution systems and those who connect facilities to the transmission and distribution systems.

The planning criteria to be applied to the *transmission and distribution systems* are also contained within these *Rules*. Prospective *Users* and existing *Users* who wish to connect *facilities* to the *transmission and distribution systems* must submit a *Connection Application* to Horizon Power.

As this document is subject to amendment, people referring to this document are advised to contact Horizon Power to ensure that they have the latest version. Horizon Power' contact details are:

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1.1 Scope

(a) This chapter 1 defines the scope of the *Rules* both as to their content and their application. It provides *Rules* of interpretation and refers to the dispute resolution process. It establishes the obligations of all parties and defines the 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 the electricity *network*;

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

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

1.2 Authorisation

These *Rules* 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* including *generating equipment connected* to the *transmission* and *distribution systems*;

(c) the requirements for the operation of the *generating systems*, *transmission* and *distribution systems* (including the operation in emergency situations or where there is a possibility of a person suffering injury);

(d) the obligations of *Users* to test *equipment* in order to demonstrate compliance with the technical requirements referred to in subclause 1.2(b) and the operational requirements referred to in subclause 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) procedures relating to the operation of *generating units*;

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

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

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

(k) the procedures for the *disconnection* of *equipment* including *generating equipment* from the *transmission* and *distribution systems*;

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

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

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

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

1.3 Application

(a) In these *Rules*, unless otherwise stated, a reference to the *Network Service Provider* refers to the Regional Electricity *Networks* Corporation (trading as Horizon Power), a statutory corporation established by the Electricity Corporations *Act* (2005) (WA) as a *service provider* for the *Pilbara Grid* and the *service provider* for *Non Interconnected Systems*. These *Rules* apply to:

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

(2) *Users* of the *network* who, for the purposes of these *Rules* include:

(A) every person including a *Generator* who seeks access to *spare capacity* or *new capacity* on the *network* or makes a *connection application* in order to establish a *connection point* or modify an existing *connection;*

(B) every person including a *Generator* to whom *access* to *transmission* and *distribution capacity* is made available (including every person with whom the *Network Service Provider* has entered into a *connection agreement*).

(b) These *Rules* make use of sections of the Western Australian *Electricity Networks Access Code (2004) (Access Code)*. As legislation the *Access Code* currently covers only the South West Interconnected System, however where these *Rules* make use of the *Access Code*, those sections of the *Access Code* shall apply as part of these *Rules*.

(c) These *Rules* make use of sections of the *Pilbara Network Rules* and the *Pilbara Access Code*. As legislation the *Pilbara Network Rules* and *Pilbara Access Code* apply only to the *Pilbara Grid* and apply in addition to these *Rules.* Where these *Rules* make use of the *Pilbara Network Rules* or the *Pilbara Access Code*, those sections of the *Pilbara Network Rules* or the *Pilbara Access Code* shall apply as part of these *Rules*.

1.4 Commencement

These *Rules* came into operation on 1 July 2007 (the "*Rules commencement date*"). Where the *Rules* have been amended or revised, the commencement date of each revision is the date on the cover page. The amended or revised clauses do not apply retrospectively.

For the installation of new *equipment* to an existing facility, upgrading or modifying of existing *equipment* and for any contracts requiring renewal, compliance with the *Rules* and all amendments and revisions current at the date of application or renewal is required unless agreed upon with confirmation provided in writing from the *Network Service Provider*.

1.5 Interpretation

(a) In these *Rules*, the words and phrases defined in Attachment 2 have the meanings given to them there.

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

1.6 *Network Service Provider*s and *User*s to Act Reasonably

1.6.1 Importance of objectives

Network Service Providers and *Users* must comply with these *Rules* and act in a manner consistent with the objectives of these *Rules* as set out in subclause 1.1(b).

1.6.2 Acting reasonably

(a) *Network Service Providers* 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

(a) Resolution of disputes concerning these *Rules* must be made in accordance with:

(1) Chapter 13 of the *Pilbara Network Rules* for disputes related to the *Pilbara Grid*.

(2) Chapter 10 of the *Access Code* for disputes related to all other networks covered by these *Rules*.

NOTE:	*Users* connecting or connected to the *Pilbara Grid* may raise disputes in relation to both the *Rules* and *Pilbara Harmonised Technical Rules.* The application of the process provided for in Chapter 13 of the *Pilbara Network Rules* for disputes concerning these *Rules* related to the *Pilbara Grid* enables the simultaneous resolution of disputes under both these *Rules* and the *Pilbara Harmonised Technical Rules,* where possible.

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 these *Rules*; and

(3) *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 these *Rules*, to comply with that obligation.

(c) If the *Network Service Provider* or a *User* fails to arrange or control any act, matter or thing or the acts of any other person, the *Network Service Provider* or *User* is not taken to have breached such obligation imposed under these *Rules* provided the *Network Service Provider* 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 described in these *Rules*.

(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 section 4.1;

(3) permit and participate in commissioning of facilities and *equipment* which is to be *connected* to the *transmission* and *distribution systems* in accordance with section 4.2;

(4) advise a *User* with whom there is a *connection agreement* 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 section 4.1, where there are grounds to question the validity of data.

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

(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 these Rules

1.9.1 User Exemptions from these Rules

(a) An exemption from compliance with one or more of the requirements of these *Rules* may be granted to a *User* by a *Network Service Provider*.

(b) Where an exemption granted under these *Rules* may impact the operation or *security* of the *power system*, the *Network Service Provider* must consult with relevant stakeholders before deciding whether to grant the exemption.

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

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

(e) Exemptions shall be in made accordance section 64 of the *Pilbara Network Rules* for *Users* connected or connecting to the *Pilbara Grid*, and with sections 12.33 to 12.39 of the *Access Code* for *Users* connected or connecting to all other networks covered by these *Rules*.

> **NOTE:** *Users* connecting or connected to the *Pilbara Grid* may require exemptions from both these *Rules* and the *Pilbara Harmonised Technical Rules.* The application of the process provided for in section 64 of the *Pilbara Network Rules* for exemptions to these *Rules* related to the *Pilbara Grid* enables an exemption under both these *Rules* and the *Pilbara Harmonised Technical Rules* to be granted simultaneously, where possible.

1.9.2 Network Service Provider Exemptions from these Rules

(a) *The Network Service Provider* and all *applicants*, *Users* and *controllers* of the *transmission* and *distribution systems* may be exempted from one or more requirements of these *Rules.*

(b) Where the *Pilbara ISO* has granted an exemption in accordance with section 64 of the *Pilbara Network Rules* for one or more requirements of the *Pilbara Harmonised Technical Rules* to the *Network Service Provider*, the *Network Service Provider* can apply these exemptions to equivalent requirements in these *Rules.*

(c) Where the exemption granted by the *Pilbara ISO* considered in clause 1.9.2(b) also grants other *applicants*, *Users* or *controllers* an exemption related to the exemption granted to the *Network Service Provider,* the *Network Service Provider* may apply an exemption to equivalent requirements in these *Rules* to those other applicants, *Users* or *controllers*, as applicable.

1.9.3 Amendment to the Rules

(a) The *Network Service Provider* may amend these *Rules* from time to time in order to comply with relevant *written laws* and *statutory requirements*, and to be in consistence with *good electricity industry practice*.

(b) Where a *User* can demonstrate that an International or *Australian Standard*, which is not specified in these *Rules*, has equal or more onerous requirements to a specified Standard, the *User* must submit a proposal to the *Network Service Provider* to amend the *Rules* to include the proposed Standard. The submission must be supported by a report from a competent body, approved by the Australian National Association of Test Laboratories (NATA), which confirms that the requirements of the proposed International or *Australian Standards* are equal or more onerous to those of the specified Standard.

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

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

(b) When *equipment* covered by subclause 1.9.4(a) is upgraded or modified for any reason, the modified or upgraded *equipment* must comply with the applicable requirements of these *Rules*. This does not apply to other *equipment* that existed at the *Rules commencement date* and that forms part of the same *facility*.

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 chapter 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

2.2.1.1 Frequency Variations for the *Pilbara Grid*

(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 over a period of 24 hours.

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

Table 2.1 - Frequency Operating Standards - Pilbara Grid

Condition	*Frequency* Band	Target Recovery
No *contingency event* or *load* event	49.75 to 50.25 Hz	
Single contingency event	49.00 to 51.00 Hz	49.75 to 50.25 Hz within 25 minutes
Multiple *Contingency event*	48.00 to 52.00 Hz	49.75 to 50.25 Hz within 25 minutes

The *Network Service Provider* will require the use of *load shedding* facilities to aid recovery of the frequency to the range 49.0 Hz to 51.0 Hz. *Frequency* tolerance limits must be satisfied under the worst credible power system load and generation pattern, and the most severe *credible contingencies* of transmission plant including the loss of interconnecting plant leading to the formation of credible islands within the power system. With the formation of islands, each island in the power system, which contains generation, must have sufficient *load shedding* facilities to aid recovery of frequency to the range 49.75 Hz to 50.25 Hz.

NOTE: An island is formed when the *interconnection* between parts of the interconnected *transmission* system is broken.

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

(e) *Generating units* and *power stations* connected to the *Pilbara Grid* are required to operate in compliance with subclause 3.3.3.2(b) of the *Technical Rules.*

2.2.1.2 Frequency Variations for Non Interconnected Systems

The nominal operating *frequency* of the *power system* is 50 Hz. The permitted variations are given in Table 2.2.

Table 2.2 - Frequency Operating Standards - Non Interconnected Systems

Condition	*Frequency* Band Normal Operation	Frequency following *single contingency event* or *load event*
Normal operation and following *single contingency event* or *load* event	49 to 51 Hz (less than 5 secs continuously outside this range permitted)	45 to 55 Hz (less than 5 secs continuously outside this range permitted)

The *Network Service Provider* will require the use of *load shedding* facilities to aid recovery of the frequency to the range 49.0 Hz to 51.0 Hz. *Frequency* tolerance limits must be satisfied under the worst credible power system load and generation pattern, and the most severe credible contingencies of plant, and under normal operation.

2.2.2 Steady State Power Frequency Voltage

(a) This clause 2.2.2 does not apply to the *Pilbara Grid.* The steady state *power frequency voltage* requirements for the *Pilbara Grid* are specified in the *Harmonised Technical Rules.*

(b) Except as a consequence of a non-credible *contingency event*, the minimum steady state *voltage* on the *transmission system* and those parts of the *distribution system* operating at *voltages* of 6.6 kV and above must be 90% of nominal *voltage* and the maximum steady state *voltage* must be 110% of nominal *voltage*.

(c) For those parts of the *distribution system* operating at low voltage, the steady state *voltage* must remain within the limits derived from AS 61000.3.100 (2011):

Table 2.3 - Low voltage distribution system steady state voltage limits

Limit	Phase-to-Phase *voltage* (for balanced three phase network)
V100%	456 V
V99%	440 V
V1%	376 V
V0%	360 V
Vx% is the xth percentile of the steady state voltage measured in accordance with *AS* 61000.3.100 (2011)	

(d) Step *changes* in steady state *voltage* levels resulting from switching operations must not exceed the limits given in Table 2.4.

(e) Where more precise control of *voltage* is required than is provided for under subclause 2.2.2(a) and 2.2.2(c), a target range of *voltage* magnitude at a *connection point*, may be agreed with a *User* and specified in a *connection agreement*. This may include different target ranges under normal and post-contingency conditions (and how these may vary with *load*). Where more than one *User* is supplied at a *connection point* such that independent control of the *voltage* supplied to an individual *User* at that *connection point* is not possible, a target must be agreed by all relevant *Users* and the *Network Service Provider*. Where *voltage* magnitude targets are specified in a *connection agreement*, *Users* should allow for short-time variations within 5% of the target values in the design of their *equipment*.

Table 2.4 - Step-change voltage limits

Cause	**Pre-switching *(quasi steady-state) and during tap –changing***			**Post-switching (final steady state)**	
				***Transmission* (≥ 66 kV)**	***Distribution* (< 66 kV)**
Routine Switching[1]	**r** **$(hour^{-1})$**	**ΔU_{dyn}[3]/U_N[4]**		*Transmission voltages* must be between 110% and 90% of nominal *voltage*	*Must attain steady state limits*
		Distribution	***Transmission***		
	r ≤ 1	±.4.0%	±.3.00%		
	1< r ≤ 10	±.3.0%	±.2.5.0%		
	10< r ≤100	±.2.0%	±.1.5%		
	100< r ≤ 1000	±.1.25%	±.1.0%		
Infrequent Switching [2]	+6%, –10% (max)			*Transmission voltages* must be between 110% and 90% of nominal *voltage*	*Must attain steady state limits*

NOTES:

1. For example, capacitor switching, *transformer* tap action, motor starting, start-up and shutdown of *generating units*.
2. For example, tripping of *generating units*, *loads*, lines and other components.
3. **ΔU_{dyn}** is the dynamic *voltage change* which has the same meaning in *AS*/NZS 61000.3.7.
4. **U_N** is the nominal *voltage*

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 2.5 for 99% of the time.

Table 2.5 - Planning levels for flicker severity

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

NOTES:

1. These values were chosen on the assumption that the transfer coefficients between MV or HV systems and LV systems are unity. The planning levels could be increased in accordance with *AS/NZS* 61000.3.7 (2001).
2. The planning levels in Table 2.5 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 2.6 and Table 2.7 (as applicable) appropriate to the *voltage* level, whereas the inter harmonics *voltage* must not exceed the planning levels of *AS*/NZS 61000.3.6 (2001).

Table 2.6 - Distribution planning levels for harmonic voltage in networks with system voltage less than or equal to 35 kV (in percent of the nominal voltage)

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

Table 2.7 - Transmission planning levels for harmonic voltage in networks with system voltage above 35 kV (in percent of the nominal voltage)

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

Notes:

1. The planning levels in Table 2.6 and Table 2.7 are not intended to apply to harmonics arising from uncontrollable events such as geomagnetic storms, etc.
2. The total harmonic distortion (THD) is calculated from the formula:

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

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 2.6 and Table 2.7 are consistent with *AS* 61000 (2001)

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 2.8.

Table 2.8 - Limits for negative phase sequence component of voltage (in percent of the positive phase sequence component)

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

2.2.6 *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 AS* 2344 (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* must remain in *synchronism* following a *credible contingency event*. The *Network Service Provider* shall ensure that consideration is given to the requirement of *generating units* connected to the *non-interconnected systems* remaining 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 subclause 2.2.8(a), 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

(a) This clause 2.2.10 does not apply to the *Pilbara Grid.* The temporary *over-voltage* requirements for the *Pilbara Grid* are specified in the *Harmonised Technical Rules.*

(b) As a consequence of a *switching event or* credible contingency event, the power frequency voltage at all locations in the power system operating at greater than 1 kV must remain within the over-voltage envelope shown in Figure 2.1.

(c) As a consequence of a switching event or credible contingency event, the power frequency voltage at all locations in the *low voltage distribution system* operating at 1 kV or greater must remain within the over-voltage envelope shown in Figure 2.2.

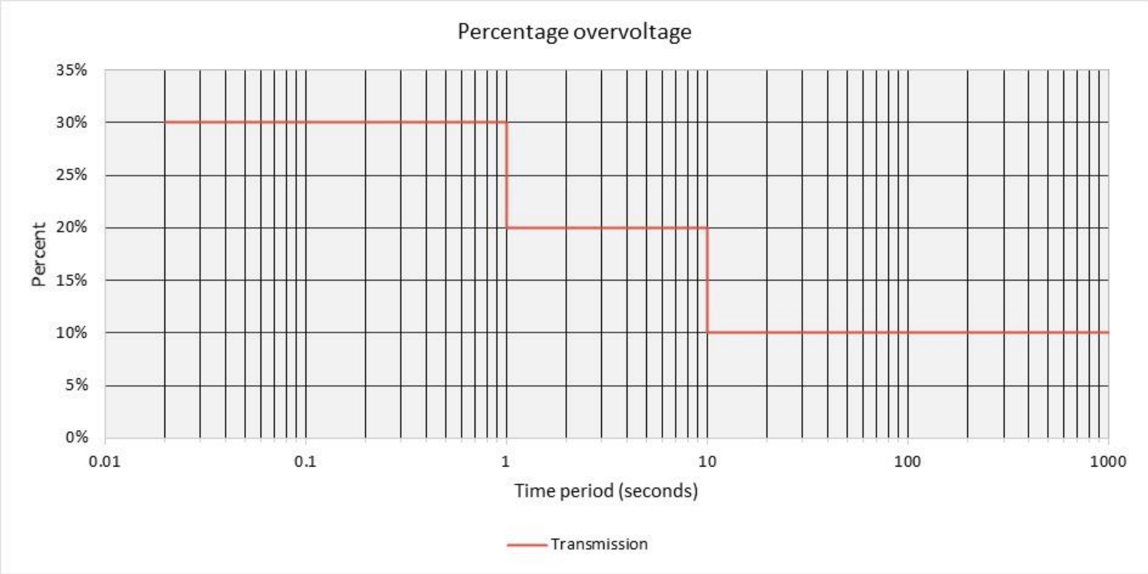

Figure 2.1 - Percentage Overvoltage Envelope at locations operating at greater than 1 kV

Note: In Figure 2.1 the percentage *voltage* level refers to the nominal *voltage* and the *voltage* is the RMS phase to phase *voltage*.

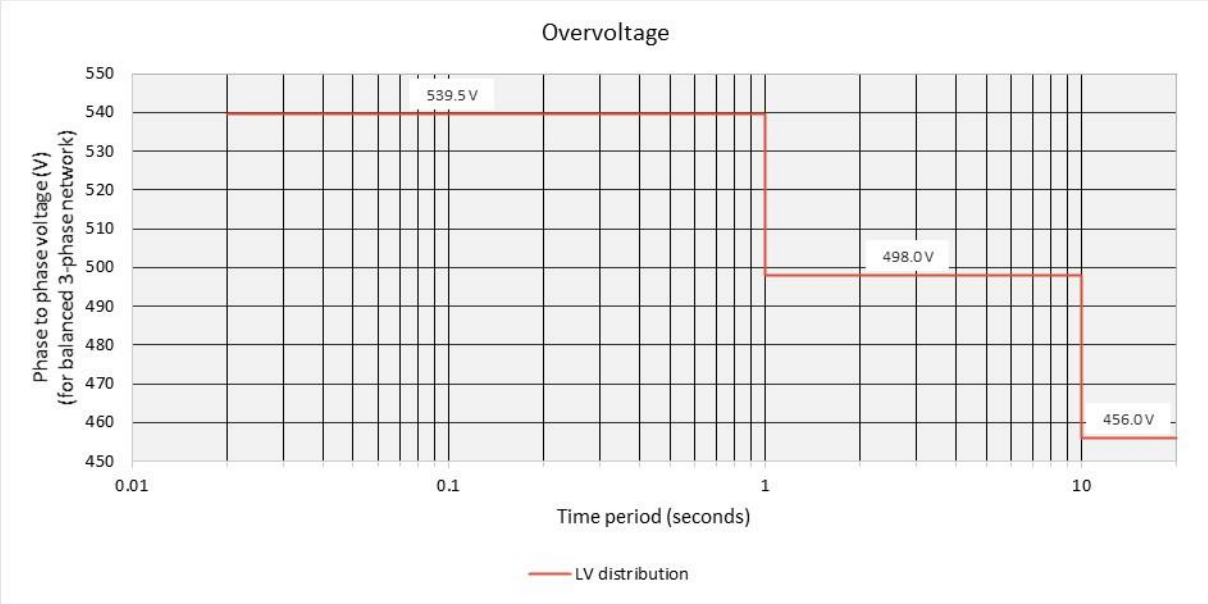

Figure 2.2 - Overvoltage Envelope – Low Voltage Distribution System

2.2.11 *Long Term Voltage Stability*

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

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

2.3 Obligations of *Network Service Provider* in Relation to Power System Performance

2.3.1 *Frequency Control*

(a) *Network Service Providers* must design and install an automatic *load shedding* system on the *transmission* and *distribution systems* to ensure that the *frequency* performance of the *power system* following a *contingency event*, as specified in Table 2.1 and Table 2.2, can be achieved.

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

2.3.2 Load to be Available for Disconnection

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

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

(2) the automatic control of *pre-emptive load shedding* relays;

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

(4) the automatic control of under *voltage* 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* to be available for automatic *disconnection*, 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. *Network Service Providers* must advise *Users* if this additional requirement is necessary.

(c) *Network Service Providers* 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 *network* 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 subclauses 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*/NZS 61000.3.7 (2001).

(c) If the *User* cannot meet the contribution calculated by using the method of subclause 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*/NZS 61000.3.7 (2001).

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

2.3.4 Harmonics

(a) To ensure that the harmonic or inter-harmonic level at any *point of common coupling* on the *network* 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 inter-harmonic 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 (1999). Harmonics must generally be measured up to h=40. However, higher order harmonics up to 100th order may be measured if the *Network Service Provider* reasonably considers them to be of material concern.

2.3.5 Negative Phase Sequence Voltage

(a) If the maximum level of negative phase sequence *voltage*, as specified in Table 2.8, is exceeded at any *connection point* on the *network*, the *Network Service Provider* must remedy the problem to the extent that it is caused by the *network*.

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

2.3.6 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 *network*, 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 Stability and Modelling Guidelines

(a) The *Network Service Provider* must develop, publish and maintain a '*Network Modelling Procedure*'

(b) The '*Network Modelling Procedure*' should clarify:

   (1) The *Network Service Provider's* approach to developing and maintaining accurate computer model(s); and

   (2) The requirements for *User's* to provide computer models and associated information for new connections or modification to existing facilities.

(c) The *'Network Modelling Procedure'* should be consistent with the Computer Model requirements specified in clause 3.6.12 of the *Harmonised Technical Rules*.

2.3.7.2 Short Term Stability

(a) The *Network Service Provider* must plan, design and construct the *network* so that the short term *power system stability* and *dynamic performance* criteria specified in clauses 2.2.7 to 2.2.10 are met for credible system *load* and *generation* patterns, and for the particular location, the most critical, *credible contingency event* without exceeding the rating of any *power system* component or, where applicable, the allocated *power transfer* capacity.

(b) To ensure compliance with subclause 2.3.7.2(a), the *Network Service Provider* must simulate the short term *dynamic performance* of the *power system*. Dynamic models of individual components must be verified and documented.

(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 section 2.4; and

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

(d) The *Network Service Provider* must determine the credible system *load* and *generation* patterns to be assumed for the purpose of short term stability analysis. Where practical, the *Network Service Provider* should set *power transfer* limits for different *power system* conditions, as provided for in subclause 2.3.8(a), so as not to unnecessarily restrict the *power transfer* capacity made available to *Users*.

2.3.7.3 Short Term Voltage Stability

(a) The assessment of the compliance of the *network* with the different short term *voltage stability* criteria specified in section 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.

2.3.7.4 Long Term Voltage Stability

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

(b) The long term *voltage stability* analysis must then be carried out by a series of *load*-flow simulations of the *transmission system* and, where necessary, the *distribution system* or by using dedicated long-term dynamics software to ensure that adequate *reactive power reserves* are provided within the *network* 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 subclause 2.3.7.4(b) using the following procedure:

(1) the normal peak *power system generation* pattern, or other credible *generation* pattern determined by operational experience to be more critical,

that provides the lowest level of *voltage* support to the area of interest must be assumed. Of the *generating units* normally in service in the area, the *generating unit* that has the largest impact on that area must be assumed to be out-of-service due to a breakdown or other maintenance requirements. If another *generating unit* is assigned as a back-up, that *generating unit* may be assumed to be brought into service to support the *load* area; and

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

(4) 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*;

(5) 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

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

2.3.7.5 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 2.3.7.4 and chapter 3 are valid. This may include *power system* and plant performance tests in accordance with section 4.1.

2.3.8 Determination of Power Transfer Limits

(a) *Network Service Providers* must assign, on a request by a *User*, *power transfer* limits to *equipment* forming part of the *network*. The assigned *power transfer* limits must ensure that the system performance criteria specified in section 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 and, consistent with the requirements of these *Rules*, should to the extent practicable maximise the *power transfer* capacity made available to *Users*.

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

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

2.3.9 Assessment of Power system Performance

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

(b) The *Network Service Provider* must ensure that system performance parameter measurements to ensure that the *power system* complies with the performance standards specified in clauses 2.2.1 to 2.2.5 are taken as specified in Table 2.9. Records of all test results must be retained by the *Network Service Provider*.

Table 2.9 - Power Quality Parameters Measurement

Parameter	Value measured	*Frequency* of measurement	Minimum measurement period	Data sampling interval
Fundamental *Frequency*	Mean value over interval	Continuous	all the time	10 seconds
Power-*frequency* *voltage* magnitude	Mean RMS value over interval	In response to a complaint, or otherwise as required by the *Network Service Provider*.	one week	10 minutes
Short-term flicker severity	P_{st}	In response to a complaint, or otherwise as required by the *Network Service Provider*.	one week	10 minutes
Long-term flicker severity	P_{lt}	In response to a complaint, or otherwise as required by the *Network Service Provider*.	one week	2 hours
Harmonic / inter-harmonic *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 Transmission and Distribution System Planning Criteria

2.4.1 Application

The planning criteria in this section 2.4 apply only to the *network* 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 chapter 3 (Technical Requirements of *User* Facilities).

2.4.2 Transmission system

The *Network Service Provider* must design the *transmission system* in accordance with the applicable criteria described below:

2.4.2.1 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* and to *zone substations* that could be lost during *peak load* and the *transmission system* maintains *steady state power system performance standards.*

(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 *network* to the extent that this is possible and that spare *power transfer* capacity is available. If insufficient back-up *power transfer* capacity is available, *load shedding* is permissible. Where a *supply* loss is of long duration, the *Network Service Provider* must endeavour to ration access to any available *power transfer* capacity by rotating the *load shedding* amongst the *Consumers* affected.

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

2.4.2.2 N-1 Criterion

(a) Any sub-*network* of the *transmission system* that is not identified within this clause 2.4.2 as being designed to the N-0 criterion must be designed to the N-1 planning criterion.

(b) For sub-*networks* of the *transmission system* designed to the N-1 criterion, *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*, except the CLB-SHT 220 kV interconnection.

(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 section 2.2, with the exception of the CLB-SHT 220 kV interconnection that shall operate in accordance with the *power system* performance standards within 30 minutes of the loss of that interconnection.

(d) Notwithstanding the requirements subclauses 2.4.2.2(b) and 2.4.2.2(c), where the failed *transmission element* is a *zone substation supply transformer*, *supply* may be lost for a brief switching period while *loads* are transferred to un-faulted *supply transformers* by means of *distribution system* switching. The *Network Service Provider* must maintain sufficient *power transfer* capacity to allow *supply* to all *Consumers* to be restored following switching.

2.4.3 Low Voltage Distribution System

2.4.3.1 Pole to Pillar Connection Points Mandatory

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

2.4.4 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.

2.4.5 Maximum Fault Currents

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

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

(1)	415 V *networks*	31.5 kA where supplied from one *transformer*; or 63 kA where supplied from two *transformers* in parallel, except where a higher *maximum fault current* is specified in a *User's connection agreement*.
(2)	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

New *equipment* should be installed with fault current withstand ratings in accordance with the values in this section, 2.4.5(b). These values are design parameters and are subject to future revision. Standard ratings for new *distribution equipment* are outlined in detail in Attachment 13.

In some circumstances, and subject to the approval of the *Network Service Provider*, *equipment* may be installed with a lower fault current rating in accordance with applicable requirements of the Electricity (Supply Standards and System Safety) Regulations 2001 where the fault level is unlikely to exceed the lower rating for *credible contingency events*.

2.5 Transmission and Distribution System Protection

2.5.1 General Requirements

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

(b) Consistent with the requirement of subclause 2.5.12.5.1(a), *protection systems* must remove faulted *equipment* from service in a timely manner and ensure that, where practical, those parts of the *transmission* and *distribution system* not directly affected by a fault remain in service.

(c) *Protection systems* must be designed, installed and maintained in accordance with *good electricity industry practice*. In particular, the *Network Service Provider* must ensure that all new *protection apparatus* complies with IEC Standard 60255 series and that all new instrument *transformers* comply with *AS* 60044 series of standards.

2.5.2 Duplication of Protection

(a) Transmission System

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

In order to maintain the integrity of the *fully independent protection schemes*, cross connections between the two schemes shall be avoided. Also, it must be possible to test and maintain either protection scheme without interference with the other.

(2) *Primary equipment* operating at *transmission system voltages* must also be protected by a *back-up protection system* in addition to the *main protection system*. The *back-up protection system* must isolate the faulted *primary equipment* if a *small zone fault* occurs, or a *circuit breaker failure* condition occurs.

For *primary equipment* operating at nominal *voltages* of 220 kV and above the *back-up protection system* must comprise *two fully independent protection schemes of differing principle* that must discriminate with other *protection schemes.*

For *primary equipment* operating at nominal *voltages* of less than 220 kV the *back-up protection system* must incorporate at least one *protection scheme* to protect against *small zone faults* or a *circuit breaker failure*.

For *protection* against *small zone faults* there must also be a second *protection scheme* and, where this is co-located with the first *protection scheme*, together they must comprise *two fully independent protection schemes of differing principle*;

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

(4) *Primary equipment* operating at a *medium voltage* that is below a *transmission system voltage* must be protected by two fully independent *protection systems* in accordance with the requirements of subclause 2.5.2(b)(1).

(b) Distribution System

(1) Each item of *primary equipment* forming part of the *distribution system* must be protected by two independent *protection systems*. One of the independent

protection systems must be a *main protection system* that must remove from service only the faulted item of *primary equipment*. The other independent *protection system* may be a *back-up protection system*;

(2) Notwithstanding the requirements of subclause 2.5.2(b)(1), where a part of the *distribution system* may potentially form a separate island the *protection system* that provides *protection* against islanding must comprise *two fully independent protection schemes of differing principle* and comply with the requirements of subclause 2.5.2(a)(3).

NOTE:	When connecting inverter connected generating units of 30 to 200 kVA to the *distribution system* in combination with an IEC 60255 compliant external generator protection relay the installation is exempt from subclause 2.5.2(b)(2).

2.5.3 Availability of Protection Systems

(a) All *protection schemes*, including any back-up or *circuit breaker failure protection scheme*, forming part of a *protection system* protecting part of the *network* must be kept operational at all times, except that one *protection scheme* forming part of a *protection system* can be taken out of service for period of up to 48 hours every 6 *months*.

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

(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*.

2.5.4 Maximum Total Fault Clearance Times

(a) This clause 2.5.4 applies to zero impedance short circuit faults of any type on *primary equipment* at nominal system *voltage*. Where *critical fault clearance times* exist, these times may be lower and take precedence over the times stated in this clause 2.5.4. *Critical fault clearance time* requirements are set out in clause 2.5.5.

(b) For *primary equipment* operating at *transmission system voltages*, the maximum *total fault clearance times* in Table 2.10 and Table 2.11 apply to the nominal *voltage* of the circuit breaker that clears a particular fault contribution for both minimum and *maximum system conditions*. For *primary equipment* operating at *distribution system voltages*, the maximum *total fault clearance times* specified for 33 kV and below may be applied to all circuit breakers required to clear a fault for *maximum system conditions*, irrespective of the nominal *voltage* of a circuit breaker.

(c) For *primary equipment* operating at a nominal *voltage* of 220 kV, operation of either *protection scheme* of the *main protection system* must achieve a *total fault clearance time* no greater than the "No CB Fail" time given in Table 2.10. Operation of either *protection scheme* of the *back-up protection system* must achieve a *total fault clearance time* no greater than the "CB Fail" time given in Table 2.10.

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

(1) one of the *protection schemes* of the *main protection system* must operate to achieve a *total fault clearance time* no greater than the "No CB Fail" time given in Table 2.10. The other *protection scheme* of the *main protection system* must operate to achieve a *total fault clearance time* no greater than the "No CB Fail" time in Table 2.11. The backup *protection system* must achieve a *total fault clearance time* no greater than the "CB Fail" time in Table 2.10, except that the second *protection scheme* that protects against *small zone faults* must achieve a *total fault clearance time* no greater than 400 ms;

(2) on 132 kV lines longer than 40 km, all main and back-up *protection schemes* must operate to achieve the relevant maximum *total fault clearance time* given in Table 2.11; and

(3) on 66 kV lines longer than 40 km, one *protection scheme* of the *main protection system* must operate to achieve the *total fault clearance times* specified for 132 kV in Table 2.11 (rather than the times specified in Table 2.10). The other *protection scheme* of the *main protection system* must operate to achieve the maximum *total fault clearance times* specified for 66 kV in Table 2.11.

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

(f) In Table 2.10 and Table 2.11, for *voltages* of 66 kV and above, the term "local end" refers to the circuit breaker(s) of a *protection system* where the fault is located:

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

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

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

(g) In Table 2.10 and Table 2.11, for *voltages* of 66 kV and above, the term "remote end" refers to all circuit breakers required to clear a fault, apart from those specified in clause 2.5.4(f).

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

(h) For *primary equipment* operating at nominal *voltages* of 33 kV and below in the NWIS, the maximum *total fault clearance times* in Table 2.10 apply for *primary equipment* operating at nominal voltages of 33 kV and below. In *Non-Interconnected systems* or *Dampier 33 kV systems*, the alternative maximum *total fault clearance times* shown in Table 2.12 and Table 2.13 apply.

(i) In Table 2.10, Table 2.12 and Table 2.13 for *primary equipment* operating at nominal *voltages* of 33 kV and below the term "local end" refers to the circuit breaker(s) of a *protection system* where the fault is located:

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

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

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

(j) In Table 2.10 and Table 2.13, for a line operating at nominal *voltages* of 33 kV and below, the term "remote end" refers to all circuit breakers required to clear a fault, apart from those specified in clause 2.5.4(i).

(k) For *protection systems* where the *primary protection scheme* is composed of graded *protection schemes*, maximum total fault clearance times are not specified.

Table 2.10 - Maximum total fault clearance times for Pilbara Grid (ms)

		New *Equipment* No CB Fail	New *Equipment* CB Fail
220 kV	Local end	120	430
	Remote end	140	430
132 kV	Local End	120	430
	Remote end	140	430
66 kV	Local End	120	430
	Remote end	140	430
33 kV and below	Local End	105	
	Remote End	105	

Table 2.11 - Alternative Maximum total fault clearance times for Pilbara Grid (ms)

		New *Equipment* No CB Fail	New *Equipment* CB Fail
132 kV	Local end	120	270
	Remote end	400	565
66 kV	Local end	105	270
	Remote end	400	565

Table 2.12 - Maximum total fault clearance times for Non Interconnected Systems (ms)

		New *Equipment* No CB Fail	**New *Equipment* CB Fail**
33 kV and below	Local end	200	500

Table 2.13 - Maximum total fault clearance times for Dampier 33 kV Systems (ms)

		New *Equipment* No CB Fail	**New *Equipment* CB Fail**
33 kV and below	Local end	300	
	Remote end	300	

2.5.5 Critical Fault Clearance Times

(a) Notwithstanding the requirements of clause 2.5.4, where necessary to ensure that the *power system* complies with the performance standards specified in section 2.2, the *Network Service Provider* may designate a part of the *network* as subject to a *critical fault clearance time*. The *critical fault clearance time* may be lower than the standard maximum *total fault clearance time* set out in Table 2.10. The *network* configurations to which the *critical fault clearance time* applies shall be specified by the *Network Service Provider*.

(b) All *primary equipment* that is subject to a *critical fault clearance time* must be protected by a *main protection system* that meets all relevant requirements of subclause 2.5.2(a). Both *protection schemes* of the *main protection system* must operate within a time no greater than the *critical fault clearance time* specified by the *Network Service Provider*.

2.5.6 Protection Sensitivity

(a) *Protection schemes* must be sufficiently sensitive to detect fault currents in the *primary equipment* taking into account the errors in *protection apparatus* and *primary equipment* parameters under the system conditions in this clause 2.5.6.

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

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

2.5.7 Trip Supply Supervision Requirements

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

2.5.8 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, unless “de-energise to trip” philosophy is employed.

2.5.9 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 chapter sets out details of the technical requirements which *Users* must satisfy as a condition of connection of any *equipment* to the *network* (including *embedded generating units*), except where granted an exemption by the *Network Service Provider* in accordance with clause 1.9.1.

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

(c) The objectives of this chapter 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*.

NOTE:	The scope of these *Rules* does not include the technical requirements for the provision of *ancillary services* under a commercial arrangement with the *Network Service Provider*. *Users* who provide these *ancillary services* may be required to comply with technical requirements over and above those specified in this chapter. These additional requirements will be specified in the relevant *ancillary services* contract.

(d) All *Users* must comply with the requirements specified in section 3.2. Additional requirements specified in this chapter may apply depending on the type of equipment within the *User's* facility, the equipment's rated capacity and connection arrangement.

a. Table 3.1 lists the sections that specify the technical requirements for *User* facilities as outlined in these *Rules*.

NOTE:	*Users* connected to the *Pilbara Grid* must comply with the *Pilbara Harmonised Technical Rules* and the requirements in these *Rules*

Table 3.1 – Technical requirements for *User* facilities

<table>
<tr><th>Equipment</th><th>Rated capacity</th><th>Operating mode</th><th>Applicable sections of these Rules</th></tr>
<tr><td colspan="4">Equipment in facilities that are not Nominated IPPs</td></tr>
<tr><td>Load</td><td>All</td><td></td><td>sections 3.1, 3.2, 3.6</td></tr>
<tr><td rowspan="4">Generating system</td><td>≥10 MW</td><td></td><td>sections 3.1, 3.2, 3.3</td></tr>
<tr><td>≤10 MW</td><td></td><td>sections 3.1, 3.2, 3.4</td></tr>
<tr><td>>30 kVA and ≤1 MVA (LV connected)</td><td></td><td>sections 3.1, 3.2, 3.5.1</td></tr>
<tr><td>≤30 kVA (LV connected)</td><td></td><td>sections 3.1, 3.2, 3.5.3</td></tr>
<tr><td rowspan="6">Energy storage facility</td><td rowspan="2">≥10 MW</td><td>consuming active power</td><td>sections 3.1, 3.2, 3.6</td></tr>
<tr><td>discharging active power</td><td>sections 3.1, 3.2, 3.3</td></tr>
<tr><td rowspan="2">≤10 MW</td><td>consuming active power</td><td>sections 3.1, 3.2, 3.6</td></tr>
<tr><td>discharging active power</td><td>sections 3.1, 3.2, 3.4</td></tr>
<tr><td>>30 kVA and ≤1 MVA (LV connected)</td><td>All</td><td>sections 3.1, 3.2, 3.5.1</td></tr>
<tr><td>≤30 kVA (LV connected)</td><td>All</td><td>sections 3.1, 3.2, 3.5.3</td></tr>
<tr><td colspan="4">Equipment in Nominated IPP facilities</td></tr>
<tr><td>Generating system in Nominated IPP facility</td><td>All</td><td></td><td>sections 3.1, 3.2, 3.8</td></tr>
<tr><td rowspan="2">Energy storage in Nominated IPP facilities</td><td rowspan="2">All</td><td>consuming active power</td><td>sections 3.1, 3.2, 3.6</td></tr>
<tr><td>discharging active power</td><td>sections 3.1, 3.2, 3.8</td></tr>
</table>

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 *network* is capable of operation while the *power system* is operating within the parameters of the *power system* performance standards set out in section 2.2.

NOTE: The over-*voltage* envelope specified in Figure 2.1. provides for the level of transient over-*voltage* excursions expected on the periphery of the *transmission* and *distribution system*. *Users* proposing to connect *equipment* that is intolerant of high *connection point voltage* may request the *Network Service Provider* to undertake a study to determine the maximum potential over-*voltage* at the proposed *connection point*. The cost of such a study will be the responsibility of the *User* requesting it.

(b) Flicker

A *User* must maintain its contributions to flicker at the *connection point* below the limits allocated by the *Network Service Provider* under clause 2.3.3.

(c) Harmonics

(1) A *User* must comply with any harmonic emission limits allocated by the *Network Service Provider* under subclause 2.3.4(a).

(2) Where no harmonic injection limit has been allocated in accordance with subclause 2.3.4(a), a *User* must ensure that the injection of harmonics or inter-harmonics from its *equipment* or *facilities* into the *networks* does not cause the maximum system harmonic *voltage* levels set out in Table 2.6 and Table 2.7 to be exceeded at the point of connection.

(d) Negative Phase Sequence Voltage

(1) A *User connected* to all three phases must balance the current drawn in each phase at its *connection point* so as to achieve 10 minute average levels of negative sequence *voltage* at the *connection point* that are equal to or less than the values set out in Table 2.8.

(e) Electromagnetic Interference

A *User* must ensure that the electromagnetic interference caused by its *equipment* does not exceed the limits set out in Tables 1 and 2 of *Australian Standard AS* 2344 (1997).

(f) Fault Levels

(1) A *User connected* to the *transmission system* may not install or connect *equipment* at the *connection point* that is rated for a *maximum fault current* lower than that specified in the *connection agreement* in accordance with subclause 2.4.5(a).

(2) A *User connected* to the *distribution system*, who is not a *small use customer*, must not install *equipment* at the *connection point* that is rated for a *maximum fault current* lower than that specified in subclause 2.4.5(b). unless a lower *maximum fault current* is agreed with the *Network Service Provider* and specified in the *connection agreement.*

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

3.2.2 Main Switch

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) *Network Service Providers* 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) Prior to a *User's* facilities being connected to the power system, the impact on power system performance due to the *User's* facilities is to be determined by power system simulation studies as specified by the *Network Service Provider* in the 'Network Modelling Procedure' (developed in accordance with clause 2.3.7.1). These studies may be performed by the *User* or a third party, in which case, the *Network Service Provider* will require full details of the studies performed, including: assumptions made; results; conclusions and recommendations.

(1) Acceptance of the studies performed by a *User* or a third party will be entirely at the *Network Service Provider*'s discretion, which is not unreasonably withheld.

(2) Acceptance of power system studies by the *Network Service Provider* does not absolve *User*s of responsibility/liability for damages or losses incurred by others.

(3) The *Network Service Provider* reserves the right to perform its own studies (at the *User's* cost) and will provide details of such studies to the *User*.

(4) The *Network Service Provider* will make the final determination on the suitability of a *User's* facilities and the requirements to be fulfilled prior to and after the facilities are connected, in accordance with these Rules.

(b) A *User* must provide to the *Network Service Provider* modelling information for their *facilities* as specified in the 'Network Modelling Procedure' produced by the *Network Service Provider*.

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

3.2.5 User's Protection Requirements

3.2.5.1 Overview

(a) The requirements of this clause apply only to a *User's protection system* that is necessary to maintain *power system security*. *Protection systems* installed solely to cover risks associated with a *User's equipment* are at the *User's* discretion. The extent of a *User's equipment* that will need to conform to the requirements of this clause will vary from installation to installation. Consequently, each installation will need to be assessed individually by the *Network Service Provider*. Information that may be required by the *Network Service Provider* in order to complete this assessment is specified in Attachment 5.

(b) The requirement for *protection systems* in respect of any *User's equipment* that forms an integral part of the *network* (as seen from the *network*) is the same as would apply under section 2.5 if that *equipment* were the *Network Service Provider's equipment*. For the purposes of this clause, a *User's equipment* forms an integral part of the *transmission* and *distribution system* when the *connection asset* (such as a circuit breaker) that is used to *disconnect* a *User's equipment* from the *network* is owned by a *User*.

(c) All *Users' equipment connected* to the *network* must be protected by *protection systems* or devices that automatically *disconnect* any faulty circuit from the *network*.

(d) A *User* 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.

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

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

(f) Except in an emergency, a *User* with *equipment connected* directly to the *transmission system* must notify the *Network Service Provider* at least 5 *business* *days* prior to taking out of service all or part of a *protection system* of any *equipment* operating at a nominal *voltage* of 66 kV or greater.

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

(h) A *Consumer* must not adjust its *protection* settings without the *Network Service Provider's* approval.

3.2.5.2 *Specific Protection Requirements for Generator Facilities*

(a) The requirements of this clause 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 system* requirements are specified in sections 3.4 and 3.5.

(b) The *protection system* for a *generating unit* must be designed to protect the *generating unit* from faults on the *network* and to minimise damage to the *generating unit* from in-feeds 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 scheme* must be capable of operating to achieve the *critical fault clearance time*. Where there is no *critical fault clearance time* both independent *protection schemes* must meet the relevant maximum *total fault clearance times* specified in clause 2.5.4.

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

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

(1) *disconnection* of the *Generator's generation* from the *network* if any of the *protection schemes* required by subclause 3.2.5.2(b) operate;

(2) separation of the *Generator's generating unit* from the *network* if there is a loss of *supply* to the *User's* installation from the *network*;

(3) prevention of the *Generator's generating unit* from energising de-energised *Network Service Provider equipment*, or energising and *supplying* an otherwise isolated portion of the *network* except where a *Generator* is contracted to provide a black start *ancillary service* and is directed to provide this service;

(4) adequate protection of the *Generator's equipment* without reliance on back up from the *Network Service Provider's protection apparatus* except as agreed with the *Network Service Provider* in accordance with subclause 3.2.5.1(d); 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'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 subclause 3.2.5.1(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 substation* in accordance with the requirements specified by the *Network Service Provider*.

NOTE: This interlock is required in addition to the islanding *protection* specified in subclause 3.2.5.2(d)(3) on account of the potential safety hazard if a de-energised *distribution feeder* was energised by an *embedded generating unit*.

3.2.5.3 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 *connection agreement*. 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 2.5.4 unless a *critical fault clearance time* applies in accordance with clause 2.5.5, 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 subclause 3.2.5.3(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 subclause 3.2.5.3(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 subclause 3.2.5.1(d), in order to clear the fault.

3.2.6 Technical matters to be coordinated

(a) The *Generator* and the *Network Service Provider* must agree upon the following matters in respect of each new or altered connection:

(1) design at *connection point*;

(2) physical layout adjacent to *connection point*;

(3) back-up (alternative) *supply* arrangements;

(4) *protection* and back-up;

(5) control characteristics;

(6) communications, metered quantities and alarms;

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

(8) fault levels and fault clearing times;

(9) switching and isolation facilities;

(10) interlocking arrangements;

(11) synchronising facilities;

(12) under *frequency load shedding* and islanding schemes; and

(13) any special test requirements.

(b) As an alternative to *distribution system augmentation*, the *Network Service Provider* may require a *Generator* to provide additional *protection schemes* to ensure that operating limits and agreed import and export limits are not exceeded.

3.3 Requirements for Connection of Large Generators (>10 MW)

3.3.1 Overview

(a) This clause addresses the particular requirements for the connection *generating units* and groups of *generating units* of aggregate rated capacity greater than 10 MW (large *power stations*).

NOTE:	The 10 MW threshold, is chosen due to the need to treat higher capacity *Generators* separately as to their requirements with respect to this clause.

(b) This clause does not apply to the connection of:

(1) *generating units* or groups of *generating units* of aggregated rated capacity equal to or less than 10 MW (small power stations), in respect of which section 3.4 applies.

(2) *generating units* or *energy systems* for which the export at the point of connection is limited to less than 1,000 kVA and the connection is to the low voltage *distribution system*, in respect of which section 3.5 applies.

(3) *Generators* that are *Nominated IPPs*, in respect of which section 3.8 applies.

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

(1) reduced *rotor angle stability*;

(2) reduced *frequency stability*; or

(3) reduced *voltage stability,*

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

NOTE:	The effect of this clause is to prevent *generating units* being permitted to connect to the *network* if, as a result of the connection of the *generator* the *power transfer capability* of the *power system* will be reduced.

(d) An unplanned trip of a *generating unit* must not cause an increased need for *load shedding* (other than any *load* which may be shed as a result of inter-trip arrangements in the *generator's* own *connection agreement* or under a *constraint*) because of:

(1) rate of *change* of *frequency;*

(2) magnitude of *frequency* excursion;

(3) *active power* imbalance;

(4) *reactive power* imbalance; or

(5) displacement of reactive capability,

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

NOTE: The effect of this clause is to limit the maximum *generating unit* size that is permitted to connect to the *network* without taking appropriate action to rectify the potential problem.

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

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

(g) 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 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, Attachment 4, and Attachment 5.

3.3.3 Detailed Technical Requirements Requiring Ongoing Verification

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

3.3.3.1 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 required under this clause within the full range of steady state *voltages* at the *connection point* permitted under clause 2.2.2.

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

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

NOTE: The *controller* must also meet the relevant performance requirements of clause 3.3.4.5.

(c) Therefore:

(1) Each *synchronous generating unit*, while operating at any level of *active power* output between its registered maximum and minimum *active power* output level, must be capable of:

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

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

Refer to Figure 3.1 for details.

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

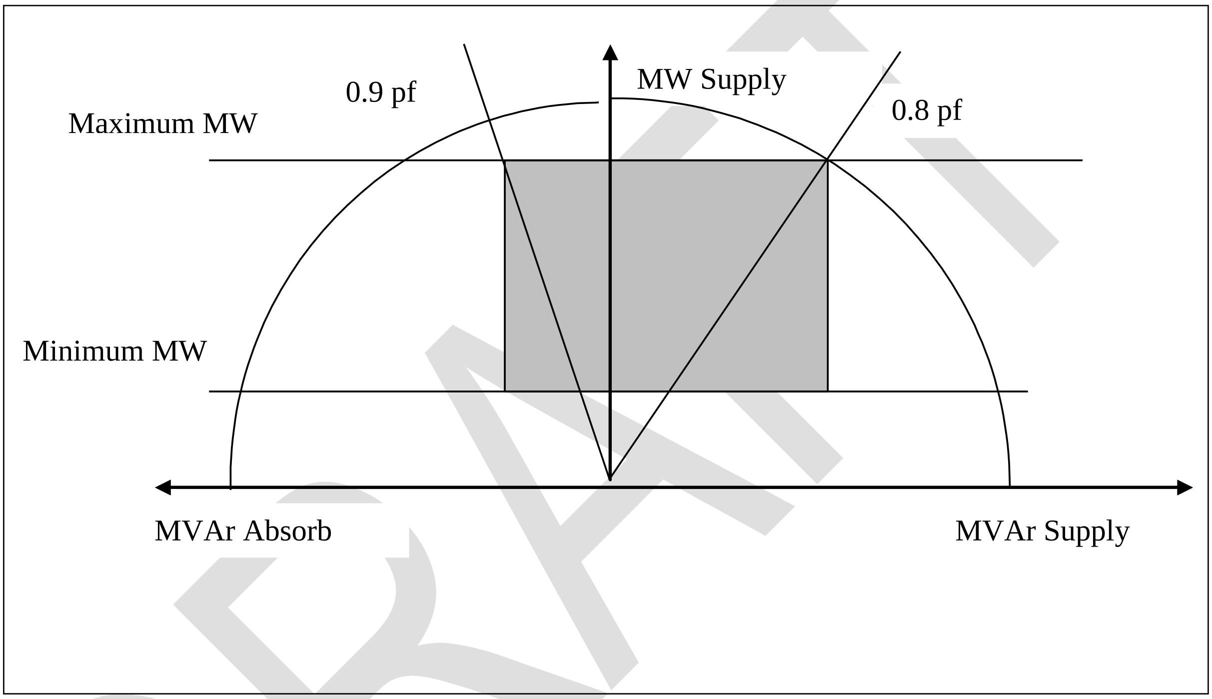

Figure 3.1 - Synchronous generating unit. Minimum reactive power capability requirements at generator machine terminals shown shaded

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

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

(3) Where necessary to meet the performance standards specified in section 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 subclause 3.3.3.1(c)(2). The need for such a requirement will be determined by *power system* simulation studies and any such a requirement must be included in the *connection agreement*.

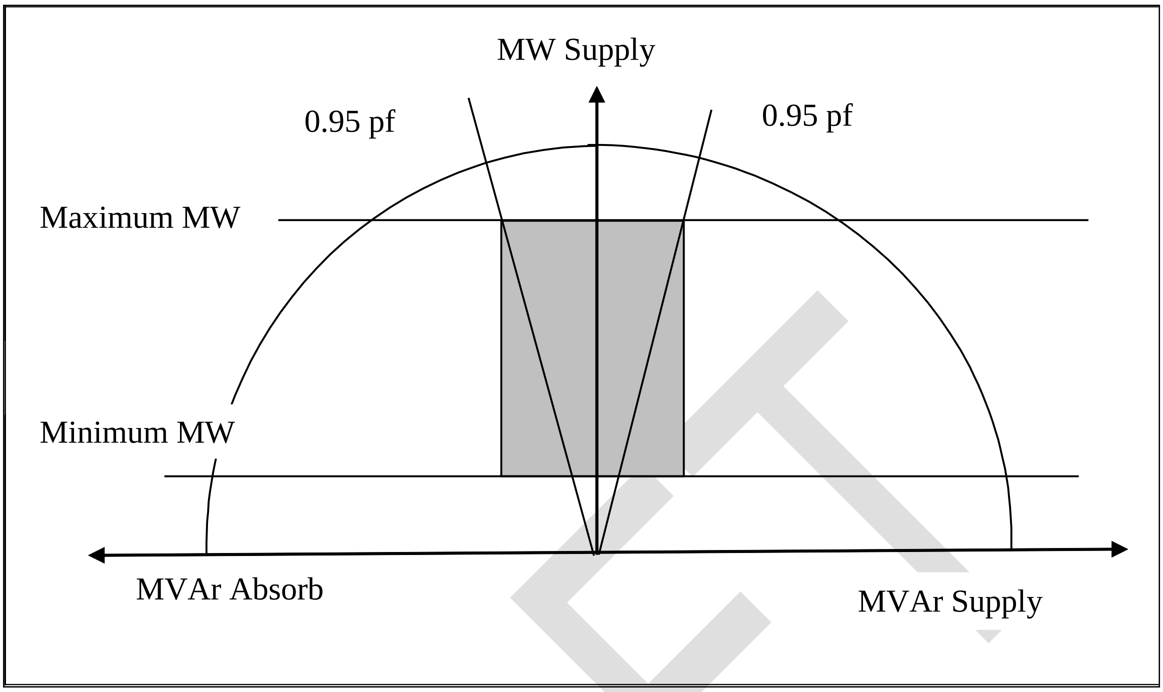

Figure 3.2 - Induction generating unit. Minimum reactive capability requirements at connection point shown shaded

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

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

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

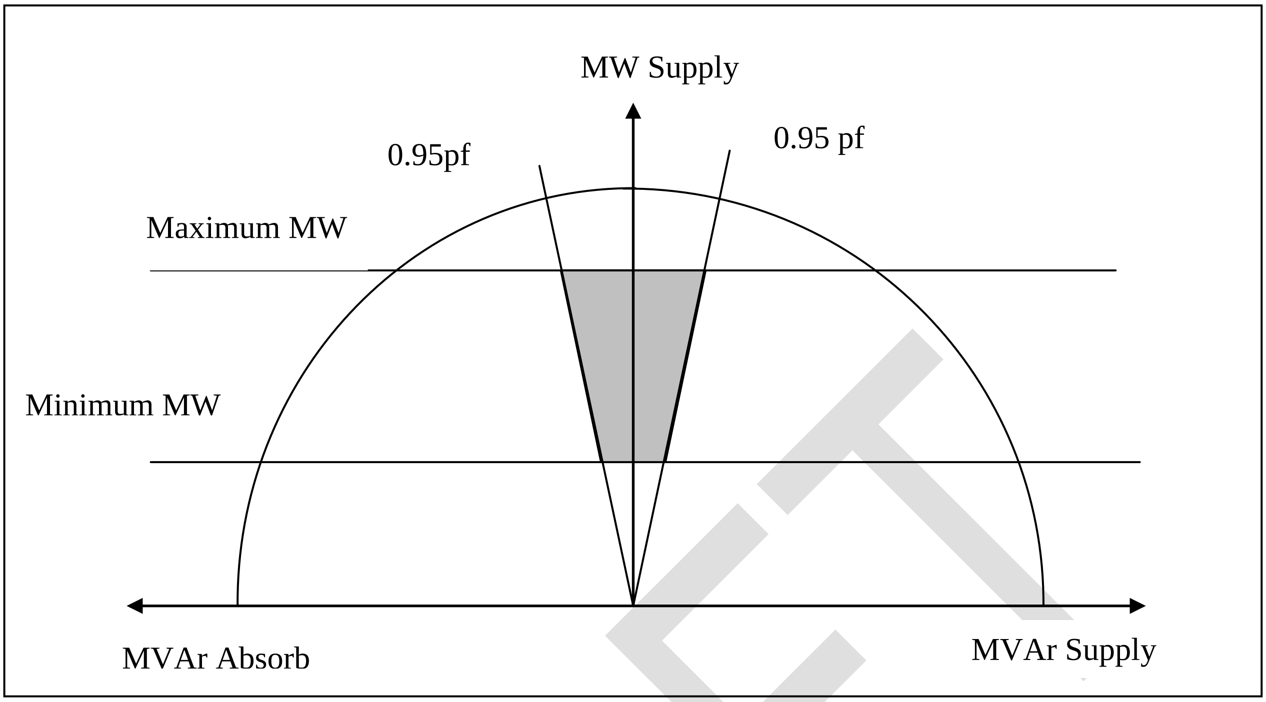

Figure 3.3 – Inverter coupled generating unit or converter coupled generating unit. Minimum reactive capability requirements at connection point shown shaded

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

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

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

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

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

3.3.3.2 Generating Unit Performance Standard

A *synchronous generating unit* or an *induction generating unit* must be designed to *generate* a constant *voltage* level with balanced phase *voltages* and harmonic *voltage* distortion equal to or less than permitted in accordance with either *Australian Standard AS* 1359 "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 *network.*

3.3.3.3 Generating Unit Response to Disturbances in the Power system

(a) Overview

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

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

(b) Immunity to Frequency Excursions in the Pilbara Grid

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. These requirements apply to both *transmission* and *distribution* connected *generating units*.

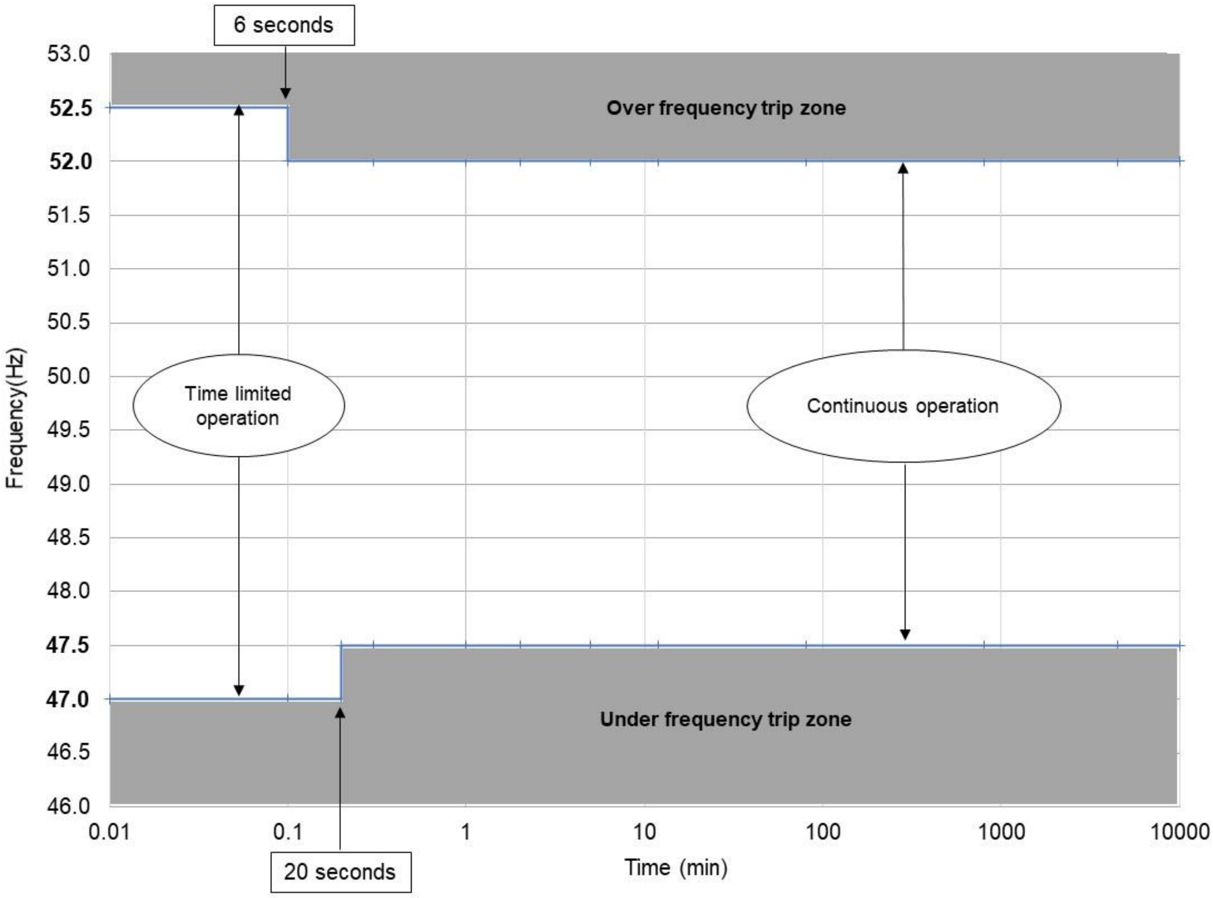

Figure 3.4 – Off nominal frequency operation capability requirement for generating units in the Pilbara Grid

NOTE:

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

(c) Immunity to Voltage Excursions

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

(2) Notwithstanding the requirements of subclause 3.3.3.2(c)(1) no *generating unit* shall be required to be capable of continuous uninterrupted operation where the *voltage* at the *connection point* falls below the envelope shown in Figure 3.5.

(3) A *generating unit* and the *power station* in which the *generating unit* is located must be capable of continuous uninterrupted operation provided the voltage at the *connection point* remains within the limits specified in clause 2.2.2 and clause 2.2.10.

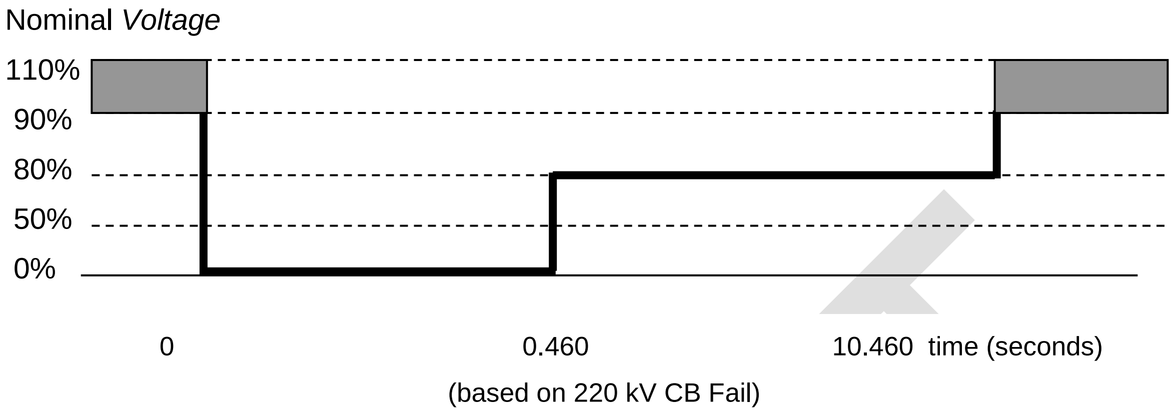

Figure 3.5 - Off nominal voltage operation capability requirement for generating units.

(d) Immunity to Rate-of-Change of Frequency on the *Pilbara Grid*

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 on the *Pilbara Grid*.

(e) Immunity to Rate-of-Change of Frequency on *non interconnected systems*

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 a maximum limit specified by the *Network Service Provider* for a *non interconnected system.*

(f) Immunity to High Speed Auto Reclosing

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

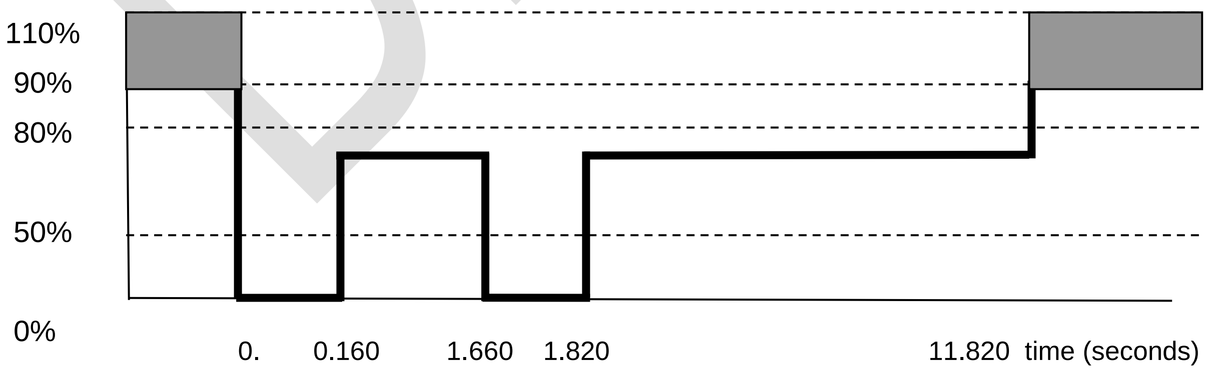

Figure 3.6 - Off nominal voltage operation capability requirement for generating units during auto-reclose operation

(g) 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* stabilise for at least 60 seconds at an above nominal value.

NOTE:	This requirement is intended for under-*voltage* situations where a *generator* is potentially exacerbating the problem.

(h) Post Fault Voltage Control of a Connection Point

Each *generating unit* must be fitted an *active power* output *controller*, such as 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 *network 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*.

(i) Continuous Uninterrupted Operation

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

(1) the *generating unit* is not *disconnected* from the *network* 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 allowances may be made for:

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

(B) any variation in *active power* output of *synchronous generating units* due to any reduction in the *power system frequency* in accordance with the registered capability of the *generating unit*.

(3) the *reactive power* control mode in which the *generating unit* was operating prior to the *credible contingency event* occurring does not *change*, unless it is required by subclause 3.3.3.2(g).

3.3.3.4 Sudden Reduction in Active Power Requirement

A *generating unit* must be capable of continuous uninterrupted operation as defined in subclause 3.3.3.3(i)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* registered minimum *active power generation* capability.

3.3.3.5 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.

3.3.3.6 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 *network* at the relevant *connection point*.

3.3.3.7 Restart Following Restoration of External Electricity Supply

(a) A *generating unit* must be capable of being restarted and synchronised to the *network* without unreasonable delay following restoration of external *supply* from the *network* at the relevant *connection point*, after being without external *supply* for 2 hours or less, provided that the *generating unit* was not *disconnected* due to an internal fault.

NOTE:

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

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

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

3.3.3.8 Protection of Generating Units from Power system Disturbances

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

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

(1) loss of *synchronism*;

(2) high or low *frequency* outside the *generator* off-nominal *frequency* operation capability requirements specified in Figure 3.4 for *generating units* connected to the *Pilbara Grid*;

(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*.

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

3.3.3.9 Generating Unit Step-up Transformer

(a) Transformer Impedance:

The maximum permitted impedance of a *generating unit step-up transformer* is 15% 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 (or medium voltage)* and *low voltage* windings.

(c) Tap Changing:

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

3.3.4 Monitoring and Control Requirements

3.3.4.1 Remote Monitoring

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

(1) provide *remote monitoring equipment* (RME) to enable the *Network Service Provider* 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.

(3) Any RME provided, upgraded, modified or replaced (as applicable) under clause 3.3.4.1, 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*.

(b) 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 *network* (may include isolation, earthing, power flow direction, voltage etc.);

(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) 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;

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

(iv) such other input information reasonably required by the Network Service Provider.

3.3.4.2 Remote control

(a) The *Network Service Provider* may, for any *generating unit* which may be unattended when *connected* to the *network*, require the *Generator* to:

(1) provide *remote control equipment (RCE)* to enable the *Network Service Provider* to *disconnect* a *generating unit* from the *network;* 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*, 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 subclause (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 section 5.9.

3.3.4.3 Communications Equipment

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

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

(c) Primary Speech Communication Channel

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

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

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

(d) Back-up Speech Communications Channel

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

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

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

3.3.4.4 Frequency Control

(a) All *generating units* must have an automatic variable speed control characteristic. *Turbine control systems* must include *facilities* for both *frequency* 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 *load*s and for *changes* in *frequency* of *the transmission and distribution system* and in a manner to sustain high initial response.

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

(d) Dead band

The dead band of a *generating unit* (the sum of increase and decrease in *power* *system frequency* before a measurable *change* in the *generating unit*'s *active power* output occurs) must be less than 0.05 Hz, unless an adjustable dead band is agreed to in the *connection agreement*.

(e) Control Range

(1) For dispatchable generating units:

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

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

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

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

(2) For *non-dispatchable generating units, a generation unit* must be capable of achieving a reduction in the *generating unit*'s *active power* output for an increase in system *frequency,* provided the latter does not require operation below *technical minimum*.

(f) Rate of Response

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

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

3.3.4.5 Voltage Control System

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

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

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

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

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

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

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

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

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

(d) *Synchronous generating units* with ratings in excess of 30 MW or smaller *generating units* within a *power station* with a total *active power* output capability in excess of 30 MW must incorporate *power system* stabiliser (PSS) circuits which modulate the *generating unit* field voltage in response to *changes* in power output and/or shaft speed and/or any other equivalent input signal approved by the *Network Service Provider*.

The stabilising circuits must be responsive and adjustable over a *frequency* range which must include frequencies from 0.1 Hz to 2.5 Hz. *Power system* stabiliser circuits may be required on *synchronous generating units* with ratings less than or equal to 30 MW or smaller *synchronous generating units* within a *power station* with a total *active power* output capability less than or equal to 30 MW if *power system* simulations indicate a need for such a requirement.

Before commissioning of any *power system* stabiliser, the *Generator* must propose preliminary settings for the *power system* stabiliser, which must be approved by the *Network Service Provider.*

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

(f) The performance characteristics required for AC exciter, rotating rectifier and *static excitation systems* are specified in Table 3.2.

(g) The performance characteristics required for the *voltage* or *reactive power control systems* of all non-*synchronous generating units* are specified in Table 3.3.

(h) The structure and parameter settings of all components of the *control system*, including the *voltage* regulator, *reactive power* regulator, *power system* stabiliser, power amplifiers and all excitation limiters, must be approved by the *Network Service Provider*.

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

Table 3.2 - Synchronous generator excitation control system performance requirements

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

NOTES:

1. One per unit excitation *voltage* is that field *voltage* required to produce nominal *voltage* on the air gap line of the *generating unit* open circuit characteristic (Refer IEEE Standard 115-1983 - Test Procedures for Synchronous Machines). *Excitation control system* with both proportional and integral actions must achieve a minimum equivalent gain of 200.
2. Rated field *voltage* is that *voltage* required to give nominal *generating unit* terminal *voltage* when the *generating unit* is operating at its maximum continuous rating. Rise time is defined as the time taken for the field *voltage* to rise from the initial value to 90% of the final value.
3. Settling time is defined as the time taken for the *generating unit* terminal *voltage* to settle and stay within an error band of ±10% of its increment value (i.e. ±10% of the step change).
4. Field *voltage* means *generating unit* field *voltage*.

Table 3.3 - Non-synchronous generator voltage or reactive power control system performance requirements

Performance Item	Units	Limiting Value	Notes
***Sensitivity*:** A sustained 0.5% error between the reference *voltage* and the sensed *voltage* must produce an output *change* of not less than 100% of the *reactive power generation* capability of the *generating unit,* measured at the point of control.	Open loop gain (ratio)	200 minimum	1
Rise time: Time for the controlled parameter (*voltage* or *reactive power* output) to rise from the initial value to 90% of the *change* between the initial value and the final value following the application of a 5% step *change* to the *control system* reference.	second	1.5 maximum	2
***Small disturbance* settling time** Settling time of the controlled parameter with the *generating unit connected* to the *transmission or distribution network* following a step *change* in the *control system* reference that is not large enough to cause saturation of the controlled output parameter. Must be met at all operating points within the *generating unit's* capability.	second	2.5 maximum	3
***Large disturbance* settling time** Settling time of the controlled parameter following a *large disturbance*, including a *transmission or distribution network* fault, which would cause the maximum value of the controlled output parameter to be just exceeded.	second	5 maximum	3

NOTES:

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

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

(k) Excitation limiters must be provided for under excitation and over excitation of *synchronous generating units* and may be provided for *voltage* to *frequency* ratio. The *generating unit* must be capable of stable operation for indefinite periods while under the control of any limiter. Limiters must not detract from the performance of any stabilising circuits and must have settings applied which are coordinated with all *protection systems*.

3.3.5 Power station Auxiliary Transformers

In cases where a *power station* takes its auxiliary supplies through a *transformer* by means of a separate *connection point*, the *User* must comply with the conditions for *connection* of *loads* (refer to section 3.6) in respect of that *connection point*.

3.3.6 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 section 3.6), that are capable of connecting the *User's generating equipment* to the *network*.

(c) Prior to the initial *synchronisation* of the *generating unit(s)* to the *network*, the *Generator* and the *Network Service Provider* must agree on written operational procedures for *synchronisation.*

3.3.7 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*.

3.3.8 Design Requirements for Generator's Substations

A *Generator* must comply with the requirements of clause 3.6.8.

3.3.9 Computer Model

(a) A *Generator* must provide all modelling data described in the 'Network Modelling Procedure' (developed by the *Network Service Provider* in accordance with clause 2.3.7.1) to the *Network Service Provider* within the timescales specified in the procedure, as updated from time to time.

(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 specified in clause 2.2.1. 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 accordance with the 'Network Modelling Procedure', in sufficient detail to enable the dynamics of these components to be characterised in the computer model for short and long term simulation studies.

(d) A *Generator* may connect to the *network* without fully complying with the requirements of subclauses (a) to (c) of this clause 3.3.9 provided that the

Generator agrees in the relevant *connection agreement* to alternative arrangements, acceptable to the *Network Service Provider*, for the provision of a compatible software model of the *generating unit* should the *Network Service Provider* upgrade or *change* its *power system* simulation software.

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

3.4 Requirements for Connection of Small Generators (≤10 MW)

3.4.1 Overview

(a) This clause addresses the particular requirements for the connection of small *generating units* and groups of *generating units* of aggregate rated capacity up to and equal to 10 MW (small *power stations*).

(b) This clause does not apply to the connection of:

(1) *generating units* or groups of *generating units* of aggregated rated capacity greater than 10 MW (large *power stations*), in respect of which section 3.3 applies.

(2) *generating units* or *energy systems* for which the export at the point of connection is limited to less than 1,000 kVA and the connection is to the low voltage *distribution system*, in respect of which section 3.5 applies.

(3) *Generators* that are *Nominated IPPs*, in respect of which section 3.8 applies.

NOTE: The issues addressed by this clause 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.

3.4.2 Categorisation of Facilities

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

(b) Unless otherwise specified, technical requirements for *generating units* will apply at the *connection point*, rather than at the *generator machine* terminals, except that the *reactive power* requirements for *synchronous generating units* will apply at the *generator machine* terminals.

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

(1) *medium 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, 240 V or 415 V.

(3) Where a small *power station* is the only *facility connected* to a *low voltage network* the *Generator* may choose to have the *power station* assessed for compliance as if the *power station* was *medium voltage connected*. Prior to

another *User* subsequently connecting to the same *low voltage network*, the *Network Service Provider* must reassess the *power station* for compliance with the requirements for *low voltage connected power stations* and the *Generator* must rectify any non-compliance identified in the reassessment.

(d) Modes of Operation

In this clause, 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 (make before break) transfer operation, being:

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

(B) 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.

3.4.3 Information to be provided by the Generator

(a) A *Generator* must provide all information in relation to the design, construction, 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 10. Where considered necessary, by the *Network Service Provider*, additional information of the kind included in Attachment 3 may be required.

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

(2) flicker coefficients and harmonic profile of the *equipment*, where applicable and especially for wind power and inverter *connected equipment*. Data on power quality characteristics, including flicker and harmonics, in accordance with IEC 61400.2 (2006) must be provided for all wind turbines.

(c) Net import / export 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 relevant *connection agreement*.

(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) 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.

3.4.4 Safety and Reliability

(a) The requirements imposed on a *Generator* by this section 3.4 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 *Users* are paramount and *connection applications* must be evaluated accordingly. *Generators* must not connect or reconnect to the *distribution system* if the safety and *reliability* of the *distribution system* would be placed at risk.

(c) Where it is apparent that the operation of *equipment* installed in accordance with the requirements of this section 3.4 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 test or modify its relevant *equipment*.

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

(e) *Equipment* directly *connected* to the *connection point* of a small *power station* must be rated for the *maximum fault current* at the *connection point* specified in clause 2.4.5.

(f) A *Generator* must ensure that the *maximum fault current* contribution from a *generating unit* or small *power station* is not of a magnitude that will allow the total fault current at the *connection point* to exceed the levels specified in clause 2.4.5 for all *distribution system* operating conditions.

3.4.5 Requirements of section 3.3 applicable to small Generators

Table 3.4 lists provisions of section 3.3 that apply to small *power stations* in addition to the requirements of section 3.4.

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

Clause	Requirement
3.3.3.1	*Reactive power capability*
3.3.3.3	*Generating unit* response to disturbances in the *power system* Except that *power stations* with less than 200 kVA aggregate capacity need not comply with subclauses (c) and (g) unless directed otherwise by the *Network Service Provider*
3.3.3.8	*Protection* of *generating units* from *power system* disturbances
3.3.4.4	*Frequency control* Except that *non-dispatchable induction generating units* need not comply with subclauses (a), (b), (d) and (e)(2) and (f)(2); and Except that *non-synchronous power stations* with less than 200 kVA aggregate capacity do not have to comply with subclauses (a), (b) and (d).
3.3.4.5	*Voltage control system* Except that *non-synchronous generating units* may be fitted with *power factor control systems* utilising modern technology, unless *power system* studies show that fast acting *voltage* and/or *reactive power control systems* complying with subclause (c) are required; Subclause (e) does not apply; and For *power stations* with a capacity of less than 200 kVA subclause (f) is replaced with: *"Generating units* must have *voltage control systems* that ensure that the requirements of clause 3.4.8 are met at the *connection point*."
3.3.3.5	*Ramping Rates* Except that *power stations* with less than 200 kVA aggregate capacity need not comply unless directed otherwise by the *Network Service Provider.*

3.4.6 Generating unit characteristics

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

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

3.4.7 Connection and Operation

3.4.7.1 Generators' Substations

Generators' substations through which *generating units* are *connected* to the *distribution system* must comply with the requirements of clause 3.6.8.

3.4.7.2 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 and lockable isolation and test points accessible to the *Network Service Provider's* operational personnel. This may be a withdrawable switch, a switch with visible contacts, a set of removable links or other approved means. It must be possible for the *Network Service Provider's* operational personnel to fit safety locks on the isolation point.

NOTE: *Low voltage generating units* with moulded case circuit breakers and fault limiting fuses with removable links are acceptable for isolation points in accordance with subclause 3.4.7.2(c).

3.4.7.3 Synchronising

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

(b) Check synchronising must be provided on all *generating unit* circuit breakers and any other switching devices that are capable of connecting the *User's generating equipment* to the *distribution system* unless otherwise interlocked to the satisfaction of the *Network Service Provider*.

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

3.4.7.4 Safe Shutdown without External Supply

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

3.4.8 *Power Quality and Voltage Change*

(a) A *Generator* must ensure that the performance standards of section 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 2.2.2. These requirements may be achieved by synchronising individual *generating units* sequentially. On *low voltage* feeders, *voltage changes* 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 cause *voltage* limits specified in section 2.2 to be exceeded and, unless otherwise agreed with the *Network Service Provider*, must not exceed 2%.

NOTE:	The 2% limit on the *voltage* rise specified in this subclause 3.4.8(c) may be waived if the *Generator* is contracted by the *Network Service Provider* for the provision of *voltage* control services. Such a waiver is most likely to be necessary at fringe of *distribution system* locations.

(d) When operating unsynchronised, a *synchronous generating unit* in a small *power station* must generate a constant *voltage* level with balanced phase *voltages* and harmonic *voltage* distortion equal to or less than permitted in accordance with either *Australian Standard AS* 1359 (1998) - "General Requirements for Rotating Electrical Machines" or a recognised relevant international standard, as agreed between the *Network Service Provider* and the *User*.

3.4.9 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 Service Provider* may require the *Generator* to provide remote monitoring and remote control of some functions in accordance with subclause 3.4.9(a).

(c) A *Generator* must provide a continuous communication link with the *Network Service Provider's control centre* for monitoring and control for *generating units* exporting 1 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 centre*. For *generating units* exporting above 1 MW, a back-up speech communications channel pursuant to subclause 3.3.4.3(d) may be required.

(e) The dead band of a *generating unit* or *energy* system (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, unless an adjustable deadband is agreed to in the connection agreement.

(f) A *generating unit* or *energy* system must be capable of achieving a reduction in the generating unit's active power output for an increase in system frequency, provided the latter does not require operation below *technical minimum*.

(g) A *generating unit* or *energy* system must be capable of achieving an increase in the generating unit's *active power* output for a decrease in system frequency, provided the latter does not require operation above its registered maximum *active power* output level subject to energy source availability.

3.4.10 Protection

This clause 3.4.10 applies only to *protection* necessary to maintain *power system security*. A *Generator* must design and specify any additional *protection* required to guard against risks within the *Generator's facility*.

3.4.10.1 General

(a) A *Generator* must provide, as a minimum, the *protection* functions specified in this subclause 3.4.10.1 in accordance with the aggregate rated capacity of *generating units* in a small *power station* at the *connection point*.

(b) A *Generator's* proposed *protection system* and settings must be approved by the *Network Service Provider*, who must assess their likely effect on the *distribution system* and may specify modified or additional requirements to ensure that the performance standards specified in section 2.2 are met, the *power transfer capability* of the *distribution system* is not reduced and the *quality of supply* to other *Users* is maintained. Information that may be required by the *Network Service Provider* prior to giving approval is specified in Attachment 5 and Attachment 10.

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

(d) The design of a *Generator's protection system* must ensure that failure of any *protection* device cannot result in the *distribution system* being placed in an unsafe operating mode or lead to a disturbance or safety risk to the *Network Service Provider* or to other *Users*.

NOTE: This may be achieved by providing back-up *protection schemes* or designing the *protection system* to be fail-safe, e.g. to trip on failure.

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

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

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

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

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

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

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

(j) All small *power stations* must have loss of AC and DC auxiliary *supply protection*, which must immediately trip all switches that depend on that *supply* for operation of their *protection*, except where the auxiliary *supply* is duplicated in which case the failure may be alarmed in accordance with clause 3.4.12.

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

(l) *Generating units* that are only operated in parallel with the *distribution system* during *rapid bumpless transfer* must be protected by an independent timer that will *disconnect* the *generating unit* from the *distribution system* if the bumpless transfer is not successfully completed. Automatic transfer switches must comply with *AS* 60947.6.2 (2004). For the avoidance of doubt, *generating units* covered by this clause need not comply with subclauses (f) to (k) of this clause 3.4.10.1.

NOTE: The above exemption from subclauses (f) to (k) of clause 3.4.10.1 recognises that the *rapid bumpless transfer* will be completed or the *generating unit* will be *disconnected* by the *disconnection* timer before other *protection schemes* operate. *Protection* of the *generating unit* when it is not operating in parallel with the *distribution system* is at the discretion of the *Generator*.

(m) For an inverter connected *generating system* with an aggregate rated capacity less than 200 kVA, the *Network Service Provider* may accept *protection* functions that respond to quantities measured at other locations within the *Generator's facility* provided that these *protection* arrangements:

1. are consistent with any guideline developed by the *Network Service Provider*; and
2. do not reduce the ability to maintain *power system security*.

3.4.10.2 Pole Slipping

The *Generator* must install a pole slipping *protection scheme* as a backup to primary protection, which should disconnect generators following a loss of *synchronism*, in turn following a *credible contingency event.*

3.4.10.3 Islanding Protection

(a) No small *power station* may *supply* power into any part of the *distribution system* that is *disconnected* from the *power system*.

NOTE: The *protection* against loss of external *supply* (loss of mains) may be *voltage* vector shift, directional (export) power or directional over current or any other method, approved by the *Network Service Provider,* that can detect a balanced *load* condition in an islanded state.

(b) For parallel operation (which excludes rapid or *gradual bumpless transfer*), islanding *protection schemes* of two different functional types must be provided to prevent a *generating unit* energising a part of the *distribution system* that has become isolated from the remainder of the *network* under all operating modes. The *Generator* must demonstrate that two different functional types of islanding *protection schemes* have been provided.

(c) For *power stations* rated above 1 MW, each functional type of islanding *protection scheme* must be incorporated into a physically separate *protection* relay. These may share the same *voltage* and *current transformers* but must be *connected* to different secondary windings. This requirement may be applied to *power stations* rated below 1 MW in situations where it is possible for the *power station* to support a sustained island on a part of the *medium voltage distribution system*.

(d) Except as provided in subclause 3.4.10.3(c), where a *power station* is rated at less than 1 MW the two islanding *protection schemes* may be incorporated into the same multi-function *protection* relay, provided that the overcurrent and earth fault *protection schemes* required by subclauses 3.4.10.1(f) and 3.4.10.1(g) are in a physically separate relay.

(e) Where there is no export of power into the *distribution system* and the aggregate rating of the *power station* is less than 200 kVA, islanding *protection schemes* can be in the form of a directional power function that will operate for power export. Directional overcurrent relays may also be used for this purpose.

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

(g) Islanding *protection* must operate within 2 seconds to ensure *disconnection* before the first *distribution system* reclosing attempt (typically 5 seconds). Relay settings are to be agreed with the *Network Service Provider*.

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

3.4.11 Intertripping

In cases where, in the opinion of the *Network Service Provider*, the risk of undetected islanding of part of the *distribution system* and the *Generator's facility* remains significant, the *Network Service Provider* may also require the installation of an inter tripping link between the *Generator's* main switch(es) and the feeder circuit breaker(s) in the *substation* or other upstream *protection* device nominated by the *Network Service Provider*.

3.4.12 Failure of Generator's Protection equipment

Any failure of the *Generator's protection apparatus* must automatically trip the *generating unit's* main switch except, where the affected *protection apparatus* forms part of a *protection system* comprised of *two fully independent protection schemes of differing principle*, the failure may instead be alarmed within the *Generator's facility* provided that operating procedures are in place to ensure that prompt action is taken to remedy such failures.

3.4.13 Commissioning and Testing

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

3.5 Requirements for Connection of Generation to the Low Voltage Distribution network

3.5.1 Overview

(a) This clause applies to the connection of *generating units* or *energy* systems for which the export at the point of connection is limited to less than 1,000 kVA and the connection is to the *low voltage distribution system*.

3.5.2 LV EG Connection Technical Requirements

(b) Detailed technical standards required for *connection* to the *low voltage distribution system* are published by the *Network Service Provider* in the “Low Voltage EG Connection Technical Requirements”.

(c) *Generating units* and *energy* systems covered by this clause must comply with these requirements in order to connect to the *low voltage distribution system*.

3.5.3 Basic EG Connection Technical Requirements

(a) Detailed technical standards required for *connection* embedded *generation* to the *low voltage distribution system* via a *basic EG connection* are published by the *Network Service Provider* in the "Basic EG Connection Technical Requirements".

(b) *Generating units* and *energy systems* covered by this clause must comply with these requirements in order to connect to the low voltage distribution system.

3.6 Requirements for Connection of Loads

3.6.1 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; and

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

3.6.2 Overview

(a) This clause applies to the connection of *equipment* and facilities of *Consumers* to the *network*.

(b) The requirements set out in this clause 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 *network* in the vicinity of the *connection point*.

Chapter 13 High voltage distribution systems of the *WASIR* should be referred to when preparing and submitting an application for the connection of a *Consumers high voltage* load to the *distribution* or *transmission* network.

(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*, 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 *load*ing 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.

3.6.3 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 subclause 2.2.1 occur.

3.6.4 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 occur.

3.6.5 Provision of Information

(a) Before connection to the *network*, 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 *network* 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 *connection agreement*, the *voltage* and location of the *connection point*, and characteristics of the local *network* 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 *transformers*, including measurement *transformers* to be used for metering purposes;

(6) the proposed methods of earthing cables and other *equipment* plus a single line earthing diagram;

(7) *equipment* and earth grid test certificates from approved test authorities;

(8) operational procedures;

(9) details of time-varying, non-sinusoidal and potentially disturbing *loads*;

(10) SCADA arrangements;

(11) *load* details including maximum demand profiles;

(12) a line diagram and service or incoming cable routes and sizes; and

(13) the preferred location of the *connection point*.

NOTE:	Typically, a small domestic *Consumer* will only be required to provide the data referred to in subclauses 3.6.5(b)(12) and subclause 3.6.5(b) (13).

(c) In addition to the requirements in subclause 3.6.5(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.

3.6.6 *Design Standards*

(a) The *equipment connected* to a *Consumer's connection point* must comply with the relevant *Australian Standards* as applicable at the time of first installation of the *equipment*, the Electricity (Network Safety) Regulations (2015) (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*.

3.6.7 *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 1 MVA or more are shown in the Table 3.5.

Table 3.5 - Power factor requirements for loads

Permissible Range	
Supply Voltage (nominal)	*Power factor* range (half-hour average, unless otherwise specified by the *Network Service Provider*)
220 kV	0.96 lagging to unity
66 kV / 132 kV	0.95 lagging to unity
<66 kV	0.9 lagging to 0.9 leading
Distribution Networks	0.8 lagging to 0.8 leading

(b) The *power factor* range to be met by *loads* of less than 1 MVA *connected* to the *distribution system* is 0.8 lagging to 0.8 leading. Where necessary to ensure the satisfactory operation of the *distribution system*, a different *power factor* range may be specified in the relevant *connection agreement*.

(c) The *Network Service Provider* 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 transfers* 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.

3.6.8 Design Requirements for Consumers' 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) the *transformer* vector group must be agreed with the *Network Service Provider*. The vector group must be compatible with the *power system* at the *connection point* and preference be given to vector groups with a zero sequence opening between *high or medium voltage* and *low voltage* windings.

(e) earthing of *primary equipment* in the *substation* must be in accordance with the *WA Electrical Requirements*, *AS* 2067 for *medium and high voltage equipment* or *AS*/NZS 3000 (2000) for *low voltage equipment*. The earthing system must satisfy these requirements without any reliance on the *Network Service Provider*'s *equipment*; Where it is not possible to design a compliant earthing system within the boundaries of a *User's* plant, the *Network Service Provider* must provide a *User*, access to its easement for the installation of earthing conductors and stakes where it is practical to do so and provided that this is not precluded by any legal requirement.

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

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

3.6.9 Load shedding Facilities

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

3.6.9.1 Installation and Testing of *Load shedding* Facilities

A *Consumer* that controls a *load* subject to *load shedding* in accordance with subclause 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*.

3.6.10 Monitoring and Control Requirements

3.6.10.1 **Remote Monitoring**

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

(1) provide *remote monitoring equipment* (*RME*) to enable 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 subclause 3.6.10.1(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 5.9.

(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 *network*; and

(D) relevant earth switches;

(2) alarms

(A) *protection* operation;

(B) *protection* fail;

(C) battery fail - AC and DC;

(D) *trip circuit supervision*; and

(E) *trip supply supervision*;

(3) measured values

(A) *active power load*;

(B) *reactive power load*;

(C) *load* current; and

(D) relevant *voltages* throughout the *equipment*, including *voltage* on the *Network Service Provider* side of main switch.

3.6.10.2 *Network Service Provider*'s Communications Equipment

Where *remote monitoring equipment* is installed in accordance with clause 3.6.10.1, 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.

3.6.11 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.

3.7 Requirements for Connection of *Energy Storage Facilities*

(a) The *Network Service Provider* may determine the requirements of connection of *energy storage facilities* to the network having regard to:

(1) the security of the *power system*;

(2) *good electricity industry practice*; and

(3) subject to subclauses 3.7(a)(1) and (2), the objective that the *Rules* be technology-neutral wherever practicable.

(b) Without limiting subclause 3.7(a) the *Network Service Provider* may choose to apply the *Rules* to an *energy storage facility* by treating it:

(1) In respect of its injections – as a *generating unit*; and

(2) In respect of its withdrawals – as *consumer equipment*.

3.8 Requirements for Connection of *Nominated IPP*s

3.8.1 Overview

(a) This clause addresses the particular requirements for the connection *generating units* and groups of *generating units* that are *Nominated IPPs*.

NOTE: A *Nominated Independent Power Producer (Nominated IPP)* is a *User* (typically a *Generator*) that is nominated by the *Network Service Provider* to be the primary *voltage* and *frequency* source for a *non interconnected system* and contracted to achieve the power system performance standards specified in these Rules.

3.8.2 Obligations of Nominated IPPs

(a) A *Nominated IPP* must install, operate and maintain the *Nominated IPP facilities*, and any *temporary plant*, so as to:

(1) ensure that the *electricity* supply to all *connection points* complies with the power system performance requirements detailed in clause 2.2 of these *Rules;*

(2) comply with the requirements as set out in this clause;

(3) enable the *Network Service Provider* to meet its obligations under these *Rules*; and

(4) comply with any relevant *connection agreement* with the *Network Service Provider*.

(b) A *Nominated IPP* must at all times:

(1) have in place all necessary arrangements, practices and procedures in accordance with *good electricity industry practice* to ensure that the occurrence of out of limit events (defined in clause 3.8.6), or any interruption to the supply of *electricity* meeting power system performance requirement detailed in clause 2.2 of these *Rules* is minimised; and

(2) have in place appropriate preferred *Nominated IPP* arrangements for the hire of appropriate temporary plant at short notice.

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

3.8.3 Connection Points

(a) A *Nominated IPP* shall nominate *connection points* for the connection, including the nominal voltage (kV), and capacity of each *connection point* (kVA).

(b) A *Nominated IPP* must deliver all electricity to the *Network Service Provider* to each of the *connection points* inclusive of the feeder transformer losses as measured at the *metering point*.

3.8.4 Voltage Variations

(a) The *Network Service Provider* will nominate the setpoint voltage of the *Nominated IPP facilities.* Where the setpoint voltage is expressed in terms of per unit voltage with reference to nominal voltage of the *connection point.*

(b) The *Nominated IPP facilities* must be capable of operation with a setpoint voltage in the range of 0.9 to 1.1 per unit.

(c) A *Nominated IPP* must operate the *Nominated IPP facilities* such that the *connection point* voltage is maintained in accordance with the limits set out in Table 3.6.

Table 3.6 – Voltage Setpoints and Performance Limits

Parameter	Setpoint Range	Steady State Limits	Transient Limits	Units
Setpoint Voltage	0.9 – 1.10	± 1%	± 4% (returning to steady state limits in ≤5 secs)	Per Unit

(d) The *Network Service Provider* may require *a Nominated IPP* to adjust the setpoint voltage of the *Nominated IPP facilities* from time to time. The *Network Service Provider* will provide written notice to the *Nominated IPP* of the request to change the voltage setpoint of the *Nominated IPP facilities* at least one week prior to the date that the change is required to be implemented, unless another method of achieving the setpoint voltage change of the *Nominated IPP facilities* is agreed between the *Network Service Provider* and the *Nominated IPP*.

3.8.5 *Power Frequency Variations*

(a) A *Nominated IPP* must operate the *Nominated IPP facilities* according to the frequency operating standards set out in Table 3.7.

Table 3.7 – Frequency Operating Limits

Parameter	Setpoint Value	Steady State Limits	Transient Limits	Units
Frequency	50.0	± 0.5	± 5.0	Hz

(b) A *Nominated IPP* must also operate the *Nominated IPP facilities* such that during transient network conditions the power system frequency at *connection points* returns to within the steady state limits within 5 seconds or less.

(c) The *Network Service Provider* may require *a Nominated IPP* to operate the *Nominated IPP facilities* to wider steady state limits of ± 2 Hz of nominal frequency from time to time.

NOTE: This may be necessary to accommodate short periods of off-nominal frequency associated with contingency events which utilise the curtailment capability of inverter connected generating equipment operating to AS/NZS 4777 standard. Where such operation is required, this must be agreed in advance between the *Network Service Provider* and the *Nominated IPP*

3.8.6 *Step Loads*

(a) A *Nominated IPP* must design, install, operate and maintain the *Nominated IPP facilities* to achieve the steady state voltage and frequency limits at the *connection point(s)* under all *category 1 step load* condition or less onerous conditions to the limits specified in Table 3.8.

Table 3.8 – Category 1 Step Load Performance Limits

Parameter	Out of Limit	Return to Limit
Voltage	Exceeds ± 4% of supply voltage	Returns to steady state limits for more than 5 seconds continuously
Frequency	Exceeds ± 0.5 Hz of 50 Hz for more than 5 seconds continuously	

(b) A *Nominated IPP* must design, install, operate and maintain the *Nominated IPP facilities* to achieve the voltage and frequency limits at the *connection point(s)* under all *category 2 step loads* to the limits specified in Table 3.9.

Table 3.9 – Category 2 Step Load Performance Limits

Parameter	Out of Limit	Return to Limit
Voltage	Exceeds ± 10% of supply voltage	Returns to steady state limits for more than 5 seconds continuously
Frequency	Exceeds ± 5 Hz of 50 Hz	

(c) In situations where *a Nominated IPP* is unable to maintain the voltage and frequency limits specified in Table 3.9, then the *Nominated IPP* must ensure that:

(1) the *Nominated IPP facilities* remain online and recover to the steady state limits within 5 seconds;

(2) the *Nominated IPP facilities* disconnect only faulted equipment or feeders, heathy equipment and feeders must remain in service;

(3) the *Nominated IPP facilities* recover to the steady state voltage and frequency limits within 5 seconds of restoration or reclosure of the equipment or feeder that has been disconnected due to a fault; and

(4) where auto-reclosing is enabled, protection initiated *category 2 step loads* may result subsequent to a feeder disconnection within 10 seconds. In such cases, the *Nominated IPP facilities* must recover to the steady state limits within 7 seconds of restoration or reclosure of the equipment or feeder that has been disconnected due to the fault.

(d) The *Network Service Provider* will notify the *Nominated IPP* of any impending *Network Service Provider* controlled *category 2 step loads*. No such notification will be provided by the *Network Service Provider* where protection initiated *category 2 step loads* occur in accordance with subclause 3.8.6(c)(4).

3.8.7 Synchronous Time Error

(a) A *Nominated IPP* must operate the *Nominated IPP facilities* to achieve an accumulated *synchronous time error* within ± 45 seconds variation from Australian Western Standard Time for 99% of the time over any 24 hour period.

(b) In cases where the *Nominated IPP* operates the *Nominated IPP facilities* to wider steady state frequency limits in accordance with subclause 3.8.5(c), the accumulated *synchronous time error* over any 24 hour period must be within ± 45 seconds, with periods of operation above and below nominal frequency permitted to achieve this requirement.

3.8.8 Generating Unit Performance Standard

A *synchronous generating unit* or an *induction generating unit* that forms part of a *Nominated IPP Facility* 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 "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 *network.*

3.8.9 Load and Voltage Imbalance

(a) The *Nominated IPP facilities* must be able to operate satisfactorily with levels of *system load imbalance* up to 10%.

(b) A *Nominated IPP* must operate the *Nominated IPP facilities* to achieve the negative phase sequence voltage limits specified in Table 2.8 at all connection points, measured as an average over a 5-minute period, for the load imbalance levels specified under subclause 3.8.8(a).

(c) If the maximum level of negative phase sequence voltage, as specified under subclause 3.8.8(b), is exceeded at any *connection point*, then the *Nominated IPP* must remedy the problem to the extent that it is caused by the *Nominated IPP facilities*.

3.8.10 Harmonics

The *Nominated IPP facilities* must be designed to operate continuously under the harmonic limits specified in clause 2.2.4 of these *Rules* and operated to remain within these levels of harmonic distortion at each *connection point*.

3.8.11 Power Factor Requirements

(a) *The Nominated IPP facilities* must operate continuously when supplying loads operating in the power factor range of 0.8 per unit lagging to 0.8 per unit leading at each *connection point.*

(b) *The Nominated IPP facilities* may be required to be capable of operating at load power factors outside of the range specified in subclause 3.8.11(a) where agreed with the *Network Service Provider*.

3.8.12 Distribution System Faults and Fault ride Through

(a) The *Nominated IPP facilities* must:

(1) be capable of distribution system fault ride through and providing an uninterrupted supply to each connection point until protection equipment provided and installed by the *Network Service Provider* has cleared the fault, following which the steady state voltage and frequency limits outlined in Table 3.6 and Table 3.7 should be achieved within 5 seconds of fault clearance; and

(2) be able to withstand fault currents on distribution feeders with a large real power component due the typical electrical characteristics of the *Network Service Provider's* non-interconnected systems.

(b) The *Nominated IPP* must ensure that:

(1) all drives and equipment critical to the operation of the *Nominated IPP facilities* will continue to operate effectively during system faults;

NOTE:	This may be done through the use of latched or DC contractors, and secure (DC or UPS) power supplies.

(2) the power supplies to critical monitoring, control and reporting equipment are similarly secured to ensure that these devices also operate through system faults;

(3) generators should be selected for operation that minimise the likelihood of an over-frequency event during system faults that might otherwise cause the generator(s) to trip on over speed, causing a total system shut down; and

(4) the generators, including inverter connected generators, will share transient system currents evenly to avoid system shut downs associated with uneven transient response from online generators, where system transients have the potential to trip one of several operating generators, causing overloading and cascading trips of the remaining online generators.

3.8.13 Protection Requirements

3.8.13.1 General Requirements

(a) The *Nominated IPP* must design, supply, install, commission and maintain protective devices and equipment that will adequately protect the public and the relevant power system equipment, and properly discriminate between different system faults in the *Nominated IPP's* and the *Network Service Provider*'s power systems, so as to:

(1) protect the *Nominated IPP facilities* against avoidable damage;

(2) protect each system against avoidable damage;

(3) protect persons from the risk of injury or death; and

(4) minimise the supply interruption to customers.

(b) The *Nominated IPP's* protective apparatus must be designed and operated to grade with the *Network Service Provider*'s protection equipment installed on each system.

3.8.13.2 Generator Protection Requirements

The generator protection must be designed to ensure that electrical faults in a generator alternator and the associated circuit to the generator circuit breaker are cleared by the generator circuit breaker, leaving the remaining generators operating to supply the system load.

3.8.13.3 Feeder Protection Requirements

The *Nominated IPP* must supply and install the protective apparatus as indicated below, as a minimum, on each of the feeder circuit breakers at each *Nominated IPP power facility.*

For clarity the protection functions are depicted as individual relays, however multi-function protection class relays incorporating these functions are acceptable.

(a) Over current protection must include:

(1) a minimum of 4 over current settings (functionally described in subclauses (b), (c), and (d) below;

(2) the ability to switch between 3 separate over current settings;

(3) a 'sensitive' setting to initiate a first auto-reclose trip to attempt to clear transient faults before downstream fuses blow;

(4) a 'normal' setting to grade with the down stream and upstream protection. This will initiate a second auto-reclose or lock out trip;

(5) a low fault level setting when minimum generation is operating during periods of low system load and generation capacity, when the fault current may be lower than the pick up current of the 'normal' setting. When this occurs, an input signal will be given to the O/C protection relay from the *Nominated IPP* station management system to switch the O/C protection to the low fault level setting;

(6) an overload setting to operate any high impedance fault detection and clearance system;

(7) the tripping characteristics must be selectable and include standard, very inverse, extremely inverse, and definite time as a minimum:

(8) instantaneous highset must be settable on all tripping characteristics; and

(9) a cold load pick-up feature, which can be remotely enabled or disabled.

NOTE:	The cold load pick-up, which may be as much as 150% of the load preceding the supply interruption, results from thermostat controlled and other similar loads that present a greater demand following a supply

interruption than the load existing before the interruption. The *Network Service Provider* will manage and operate the remote power system to limit the cold load pick up when restoring feeders that have been out of service for a considerable time.

(b) Earth fault protection must include:

(1) ability to measure earth fault current via residual connection of three line current transformer's, i.e. the ability to detect and clear LV earth faults

(2) separate and concurrent ability to measure earth fault current directly via a separate toroidal current transformer, i.e. the ability to detect and clear HV earth faults;

(3) the ability to auto reclose upon a fault trip;

(4) the ability to set concurrent earth fault settings on both the residual current transformer and toroidal CT inputs, i.e. the ability to set protection for both HV and LV earth faults;

(5) a minimum pick-up current of 10% of relay rated current.

(6) the tripping characteristics must be selectable and include standard, very inverse, extremely inverse, and definite time as a minimum: and

(7) instantaneous highset must be selective on all tripping characteristics.

(c) Sensitive Earth Fault Protection:

(1) The HV earth fault and HV sensitive earth fault functions are distinctly separate functions operating independently of each other, i.e. the HV sensitive earth fault function and HV earth fault operate independently and must be able to be set on different settings, reflecting their different purposes.

(2) The sensitive earth fault relay must have a definite time characteristic, with the pick-up current adjustable down to at least 2% of relay rated current. The delay time must be adjustable between 5 and 15 sec. The sensitive earth fault feature must be able to be switched off and on remotely.

(3) The remote off/on signal for the sensitive earth fault will not be provided by the *Network Service Provider*. This signal will come from the *Nominated IPP*, typically following a request from the *Network Service Provider* to switch off or on the sensitive earth fault or recloser features before or after line maintenance or fault repair work.

(d) High Impedance Fault Protection:

The *Nominated IPP* must provide details to the *Network Service Provider* in relation to its approach to detect and manage high impedance network faults, whilst maintaining full discrimination with its protection design.

NOTE: Such faults may have the characteristic of the fault demand being less than the overload capacity of a feeder circuit but beyond the capacity of the connected generation.

(e) Protection on networks with *inverter connected energy systems:*

For networks with *inverter connected energy systems*, the feeder protection must include voltage based protection and numerical relays with negative phase sequence, and under voltage with conditional overcurrent schemes. Numerical relays shall have Ethernet connectivity. In such cases, protection voltage transformers are required on the bus sections.

3.8.13.4 Protection Settings

(a) The *Nominated IPP* must provide details of the protection equipment functionality and any protection settings on the switchboards within the *Nominated IPP facilities* to the *Network Service Provider*.

(b) The 'normal' over current and earth fault settings within the *Nominated IPP facilities* must grade with the highest trip characteristic in the *Network Service Provider*'s distribution system.

(c) All protection settings within the *Nominated IPP facilities* will be reviewed and approved by *Network Service Provider* and these will also be reviewed every time a new piece of protection equipment (e.g., recloser) is installed in the *Nominated IPP facilities* or the *Network Service Provider* distribution network.

3.8.13.5 Automatic Reclosing

(a) The *Nominated IPP* must provide automatic reclosing on the outgoing feeder circuit breakers connected to their *Nominated IPP power facility* switchboard. The design of the automatic reclosing must ensure adequate discrimination with reclosing of any *Network Service Provider* circuit breakers, reclosers or fuses. The reclosing settings on the *Nominated IPP* feeders will be determined by the *Network Service Provider* and the *Nominated IPP* must apply them without cost to the *Network Service Provider*.

(b) The auto reclose feature must be able to be switched off and on remotely by *Network Service Provider*.

(c) Where the *Nominated IPP* proposes to install transformers in the feeder circuits they must be designed to withstand through fault currents to prevent damage when reclosing onto feeder faults.

NOTE:	The auto reclose element must be capable of initiating at least one reclose attempt, with the number of reclose attempts and the dead time between each reclose and the preceding trip individually adjustable for each reclose.

3.8.13.6 Under Frequency load shedding (UFLS)

(a) The *Nominated IPP* must provide under *frequency load shedding* (UFLS) on all *Network Service Provider* feeders to manage power system frequency at times of generation short fall.

(b) The UFLS detection element must be a protection class relay. Each feeder must be able to be set to trip at a different predetermined frequency and time delay. The UFLS settings and priorities of the stages of *load shedding* will be nominated by the *Network Service Provider* from time to time, as loads are connected to and switched between feeders.

(c) The *Nominated IPP* must provide the necessary signals to the *Network Service Provider* advising of an under *frequency load shedding* event, including the stages of operation, feeders tripped and when the loads shed have supplies restored.

(d) The *Nominated IPP* must provide the capability to have the priority of *load shedding* on the different feeders rotated as needed and advised by the *Network Service Provider*.

3.8.13.7 Pre-emptive Load Shedding

The *Nominated IPP* must install a *pre-emptive load shedding* system to trip sufficient feeder circuits nominated by the *Network Service Provider* to avoid a shutdown of the *Nominated IPP facilities* in case of:

(a) a generator circuit breaker opening, causing over-loading of the operating generators that remain in service;

(b) insufficient generation to meet electricity demand due to any other cause.

3.8.14 Remote Control, Monitoring and Communications

(a) The *Nominated IPP* must supply, install, commission and maintain at the *connection points,* and for each generator and feeder circuit breaker, power quality meters that:

   (1) provide the information needed to manage and demonstrate performance of its obligation under the *connection agreement*;

   (2) monitor and record to the nominated accuracy the following parameters of: circuit breaker status; energy (kWh); demand (kW); reactive power (kVA); voltage; frequency; spinning reserve (kW); power factor; voltage imbalance; current and voltage distortion including total harmonic distortion; and

   (3) any other parameters that define the supply quality and reliability specified in the *connection agreement*.

(b) The *Nominated IPP* must maintain records of the parameters specified in subclause 3.8.14(a) for the term of the operating period specified in the *connection agreement*.

(c) The *Nominated IPP* must monitor system parameters and equipment status and provide connection to its monitoring equipment to allow the *Network Service Provider* to effectively manage the overall operation of the power generation and supply systems to ensure the safe and reliable supply of electricity to all customers.

(d) The *Nominated IPP* must also supply all equipment to enable the *Network Service Provider's* remote monitoring, which must comply with a specification provided by the *Network Service Provider*.

(e) Equipment provided by the *Nominated IPP* to enable the *Network Service Provider's* remote monitoring under subclause 3.8.14(d) must be installed by the *Nominated IPP* at the *Nominated IPP facilities* and provided to the *Network Service Provider* for installation at its own control centre.

(f) The *Network Service Provider* will require physical access to its plant and equipment installed within the *Nominated IPP facilities* for routine and breakdown maintenance purposes. The *Nominated IPP* must facilitate such access as required by the *Network Service Provider.*

(g) The *Nominated IPP* must provide a copy of the data generated for its remote control system to the *Network Service Provider's* control centre, which as a minimum must include:

(h) The *Nominated IPP* must provide a telephone facility to enable communications from the *Nominated IPP facilities* to the *Network Service Provider's* representative.

(i) The *Nominated IPP* must supply a meter that is capable of recording aggregate fuel consumption and of remote reading via the SCADA system with sufficient accuracy to facilitate tariff/fuel reconciliation and station efficiency calculations.

3.8.15 General Design Requirements

(a) The *Nominated IPP* must provide feeder circuits that have withdrawable circuit breakers and which may be used as a network isolation point. The feeder circuit breakers must be remotely controllable by the *Network Service Provider*, including providing updates to protection settings and functionality. Auto reclose functionality must be able to be remotely enabled and disabled by the *Network Service Provider.*

(b) The *Nominated IPP* must provide:

(1) current transformers that have a centre tap ratio. The *Network Service Provider* will advise the maximum ratio required for each feeder at the time of detailed design to ensure future expansions are possible with minimal delays.

(2) one dual purpose (metering / protection) current transformer to be included per phase in each feeder circuit (three in total per feeder). The current transformer's must be used as dedicated current transformers for each feeder power monitor.

> **NOTE:** Specifications for dual purpose current transformer's will be provided by the *Network Service Provider* upon request.

(3) step-up transformers at the *Nominated IPP facilities* that have a tap range of ±5%, as a minimum, with tap steps of ≤5% to facilitate voltage control.

(4) a 415V system that that complies with a multiple earthed neutral design, and a HV system that is solidly earthed.

(c) The *Nominated IPP facilities* provided by the *Nominated IPP* must be equipped (complete with controls, protection and circuit breakers) with two spare generator incomer circuits on the main switchboard for use by the *Network Service Provider* to meet demand. The *Nominated IPP* must ensure that there is adequate space in the switchroom for at least one additional feeder. The switchboard must be rated for the capacity with all spare circuits occupied with generators of the largest size that are proposed initially for the *Nominated IPP facilities*.

> **NOTE:** Spare circuit positions are for use to address typical load increases associated with the *Network Service Provider's* load, not to address the *Nominated IPP's* internal needs or provide supply to non-*Network Service Provider* customers.

3.8.16 Black Start Capability

The *Nominated IPP* must install, test and maintain black start capability such that restoration of supplies to the *Network Service Provider's* supply system can be completed within 5 minutes of a forced outage that shuts down the *Nominated IPP's* supply to the *Network Service Provider*.

3.8.17 Requirements of section 3.3 applicable to Nominated IPPs

Table 3.4 lists provisions of section 3.3 that apply to *Nominated IPPs* in addition to the requirements of section 3.8.

Table 3.10 - Specific paragraphs of section 3.3 applicable to Nominated IPPs

Clause	Requirement
3.3.3.1	*Reactive power capability*

Clause	Requirement
3.3.3.3	*Generating unit* response to disturbances in the *power system*
3.3.3.8	*Protection* of *generating units* from *power system* disturbances
3.3.4.5	*Voltage control system* Except that subclauses (d), (e), (h), (i), (j) do not apply.

4 INSPECTION, TESTING, COMMISSIONING, DISCONNECTION AND RECONNECTION

4.1 Inspection and Testing

4.1.1 Right of Entry and Inspection

(a) The *Network Service Provider* or 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 these *Rules*, or any relevant *connection agreement*;

(2) investigate any operating incident in accordance with clause 5.6.3;

(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 subclause 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 *network* which the *Network Service Provider* reasonably considers requires access to a *facility*, prior notice to the *facility* owner is not required. However, the *Network Service Provider* 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 subclause 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*, for the purpose of investigating an operating incident in accordance with clause 5.6.3.

(f) At any time when the *representative* of an inspecting party is in a *facility* owner's *facility*, that *representative* must:

(1) not cause any damage to the *facility*;

(2) interfere with the operation of the *facility* only to the extent reasonably necessary and as approved by the *facility* owner (such approval not to be unreasonably withheld or delayed);

(3) observe "permit to test" access to site and clearance protocols applicable to the *facility*, provided that these are not used by the *facility* owner or any contractor or agent of the *facility* owner solely to delay the granting of access to the *facility* or its inspection;

(4) observe the requirements in relation to occupational health and safety and industrial relations matters which are of general application to all invitees entering on or into the *facility*, provided that these requirements are not used by the *facility* owner or any contractor or agent of the *facility* owner solely to delay the granting of access to the *facility*; and

(5) not ask any question other than as may be reasonably necessary for the purpose of such inspection, nor give any *direction* or instruction to any person involved in the operation or maintenance of the *facility* other than in accordance with these *Rules* or, where the inspecting party and the *facility* owner are parties to a *connection agreement*, that *connection agreement*.

(g) Any *representative* of an inspecting party conducting an inspection under this clause 4.1.1 must be appropriately qualified and experienced to perform the relevant inspection. If so requested by the *facility* owner, the inspecting party must procure that its *representative* (if not a direct employee of the inspecting party) enters into a confidentiality undertaking in favour of the *facility* owner in a form reasonably acceptable to the *facility* owner prior to seeking access to the relevant *facility*.

(h) An inspection under this subclause 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 any person who owns or occupies the land on which the *facility* is situated or any part thereof does:

(1) take reasonable steps to ensure the *security* of any such *equipment*;

(2) not use any such *equipment* or goods for a purpose other than as contemplated in these *Rules* without the prior written approval of the inspecting party;

(3) allow the inspecting party to remove any such *equipment* or goods in whole or in part at a time agreed with the *facility* owner, which agreement must not be unreasonably withheld or delayed; and

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

4.1.2 Right of Testing

(a) If the *Network Service Provider* or any *User* whose *equipment* is *connected* directly to the *transmission system* under a *connection agreement* (in this clause 4.1.2 the "requesting party") believes that *equipment* owned or operated by, or on behalf of, the other party to the *connection agreement* (in this clause 4.1.2 the "*equipment* owner") may not comply with these *Rules* or the *connection agreement*, the requesting party may require testing by the *equipment* owner of the relevant *equipment* by giving notice in writing to the *equipment* owner accordingly.

(b) If a notice is given under subclause 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* or the *Network Service Provider* as the case requires. Such agreement must not be unreasonably withheld or delayed.

(c) An *equipment* owner who receives a notice under subclause 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*, 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 subclause 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* or the *Network Service Provider* as the case requires, within a reasonable period after the completion of the test. The report must outline relevant details of the tests conducted, including, but not limited to, the results of those tests.

(h) The *Network Service Provider* may attach test *equipment* or *monitoring equipment* to *equipment* owned by a *User* or require a *User* to attach such test *equipment* or *monitoring equipment*, subject to the provisions of clause 4.1.1 regarding entry and inspection. The data from any such test *equipment* or *monitoring equipment* must be read and recorded by the *equipment* owner.

(i) In carrying out monitoring under subclause 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 subclause 4.1.2(j) or monitoring under subclause 4.1.2(i) demonstrates that *equipment* does not comply with these *Rules* or the relevant *connection agreement*, then the *equipment* owner must:

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

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

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

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

4.1.3 Tests to Demonstrate Compliance with Connection Requirements for Generators

(a) Tests:

(1) A *Generator* must provide evidence to the *Network Service Provider* that each of its *generating units* complies with the technical requirements of section 3.3 or 3.4, as applicable, and the relevant *connection agreement* prior to commencing commercial operation. In addition, each *Generator* must cooperate with the *Network Service Provider* 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 *Generators* are detailed in Table A11.1 of Attachment 11.

(2) Special tests may be specified by the *Network Service Provider* that are 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 A11.2 of Attachment 11. Where testing is not practicable in any particular case, the *Network Service Provider* may require the *Generator* to install recording *equipment* at appropriate locations in order to monitor *equipment* performance.

(3) These compliance tests must only be performed after the machines have been tested and certified by a Chartered Professional Engineer with National Professional Engineers' Register standing qualified in a relevant discipline, unless otherwise agreed, and after the machine's turbine controls, AVR, excitation limiters, *power system* stabiliser, and associated *protection* functions have been calibrated and tuned for commercial operation to ensure stable operation both on-line and off-line. All final settings of the AVR, PSS and excitation limiters must be indicated on control transfer block diagrams and made available to the *Network Service Provider* before the tests.

(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*. The *Network Service Provider* 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 section 3.3 or 3.4, as applicable, and the relevant *connection* *agreement*. The negotiations must consider the use of high speed data recorders and similar non-invasive methods for verifying the *equipment* performance to the extent that such non-invasive methods are practicable.

(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 section 3.3 and the relevant *connection agreement* then the *Generator* must:

(1) promptly notify the *Network Service Provider* of that fact;

(2) promptly advise the *Network Service Provider* of the 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 *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* reasonably believes that a *generating unit* is not complying with one or more technical requirements of section 3.3 or 3.4, as applicable, and the relevant *connection agreement*, the *Network Service Provider* 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), the *Network Service Provider* must reimburse the *Generator* for the reasonable expenses incurred as a direct result of conducting the tests.

(e) If the *Network Service Provider*:

(1) has reason to believe that a *generating unit* does not comply with one or more of the requirements of section 3.3, 3.4 or 3.8, as applicable;

(2) has reason to believe that a *generating unit* does not comply with the requirements for *protection schemes* set out in section 2.5, as those requirements apply to the *Generator* under clause 3.5.1; or

(3) either:

(A) does not have evidence demonstrating that a *generating unit* complies with the technical requirements set out in section 3.3 or 3.4 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* 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*, 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* gives a *direction* to a *Generator* under subclause 4.1.3(e) and the *Generator* neglects or fails to comply with that *direction*; or

(2) the *Network Service Provider* endeavours to communicate with a *Generator* for the purpose of giving a *direction* to a *Generator* under subclause 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* may take such measures as are available to it 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 subclause 4.1.3(e) must be recorded by the *Network Service Provider*.

(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* 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 *network* and the *User* must conduct these tests:

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

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

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

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

(1) *protection systems*;

(2) *control systems* for maintaining or enhancing *power system stability*;

(3) *control systems* for controlling *voltage* or *reactive power*;

(4) *control systems* for *load shedding*; and

(5) *control systems* for load following and dispatch.

(d) A compliance program under subclause 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 section 2.2; and

(4) be in accordance with *good electricity industry practice*.

(e) A *User*, must notify the *Network Service Provider* immediately if it reasonably believes that a *facility* of the type listed in subclause 4.1.4(c), and forming part of a registered *facility*, does not comply with, or is unlikely to comply with, relevant performance requirements specified in chapter 2.

4.1.5 Testing by Users of their own Equipment Requiring Changes to Agreed Operation

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

(b) The notice to be provided under subclause 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 and contact information 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.

(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* when the test is complete.

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

4.1.6 Tests of Generating units Requiring Changes to Agreed Operation

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

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

(1) the tests must not be scheduled for a date earlier than 15 *business days* after notice is given by the *Network Service Provider* under subclause 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 subclause 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 *network* or investigating *power system* performance must be coordinated and approved by the *Network Service Provider*.

(b) The tests described in subclause 4.1.7(a) must be conducted, if considered necessary by the *Network Service Provider* whenever:

(1) a new *generating unit* or *facility* or a *network* development is commissioned that is calculated or anticipated to alter substantially the *power transfer capability* through the *network*;

(2) setting *changes* are made to any *turbine control system* and *excitation control system*, including *power system* stabilisers; or

(3) they are required to verify the performance of the *power system* or to validate computer models.

(c) Tests as described in subclause 4.1.7(a) may be requested by the *Network Service Provider* 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 days* before any test under this clause 4.1.7 may proceed and consider any requirements of those *Users* when approving the proposed test.

(e) Operational conditions for each test must be arranged by the *Network Service Provider* 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 subclause 4.1.7(a).

(g) The *Network Service Provider* may direct the operation of *generating units* by *Users* during *power system* tests and, where necessary, the *disconnection* of *generating units* from the *network*, if this is necessary to achieve operational conditions on the *network* 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*.

4.1.8 Tests of Nominated IPP Power Facilities

(a) The *Network Service Provider* shall have the right to enter and inspect the *Nominated IPP facilities* and shall require testing in accordance with clause 4.1.3 and clauses 4.1.5 to 4.1.7 of these *Rules*.

(b) Routine testing of protection equipment, whether by the *Nominated IPP* or the *Network Service Provider*, shall be in accordance with clause 4.1.4 of these *Rules*.

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, prior to being *connected* to a *network,* it complies with:

a. these *Rules*, including relevant testing schedules and tests provided for in Chapters 3 and 4 and outlined in Attachment 11 and Attachment 12,

b. relevant Australian Standards,

c. relevant international standards,

d. the *Access Code* (as applicable),

e. the *Pilbara Network Rules* (as applicable),

f. the *Pilbara Network Access Code* (as applicable),

g. any relevant *connection agreement,* and

h. *good electricity industry practice*.

(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 these *Rules* consistent with subclause 4.1.1(a), clause 4.2.5 and clause 4.2.9.

4.2.2 Co-ordination during Commissioning

(a) A *User* seeking to connect *equipment* to a *network* must cooperate with the *Network Service Provider* to develop procedures to ensure that the commissioning of the connection and *connected facility* is carried out in a manner that:

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

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

(b) A *User* may request from the *Network Service Provider* to schedule commissioning and tests (including the relevant exchange of correspondence) at particular times that suit the project completion dates. The *Network Service Provider* must make all reasonable efforts to accommodate such a request.

(c) A *User* must not connect *equipment* to the *network* without the approval of the *Network Service Provider* who must not approve such connection before the *User's* installation has been certified for compliance with these *Rules* and the *WA Electrical Requirements*. To avoid doubt, subclause 4.2.2(c) does not apply if section 3.5 applies.

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* as appropriate; and

(2) within 20 *business days* of receipt of the design information under subclause 4.2.3(a), notify the *User* of any comments on the proposed parameter settings for the new or replacement *equipment*.

(c) If the *Network Service Provider's* comments include alternative parameter settings for the new or replacement *equipment*, then the *User* must notify the *Network Service Provider* within 10 *business days* that it either accepts or disagrees with the alternative parameter settings suggested by the *Network Service Provider*.

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

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

4.2.4 Commissioning Program

(a) Not less than 65 *business days* (or as otherwise agreed between the *User* and the *Network Service Provider*) prior to the proposed commencement of commissioning by a *User* of any new or replacement *equipment* that could reasonably be expected to alter materially the performance of the *power system*, the *User* must advise the *Network Service Provider* in writing of the commissioning program including test procedures and proposed test *equipment* to be used in the commissioning.

(b) The *Network Service Provider* must, within 20 *business days* of receipt of such advice under subclause 4.2.4(a), notify the *User* either that it:

(1) agrees with the proposed commissioning program and test procedures; or

(2) requires *changes* in the interest of maintaining *power system security*, safety or *quality of supply*.

(c) If the *Network Service Provider* requires *changes*, then the *Network Service Provider* and the *User* must cooperate 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* has 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 *network* of new or replacement *equipment* covered by subclause 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 subclause 4.2.1(a) have been completed and that the *equipment* is ready to be *connected* and energised. The statement must be certified by a Chartered Professional Engineer with National Professional Engineers' Register Standing, qualified in a relevant discipline.

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

(1) wishes to witness the commissioning tests; and

(2) agrees with the proposed commissioning times.

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

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

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

(g) All commissioning tests under this clause 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 Service Provider*. In extreme situations it may be necessary for a *User* to propose a commercial arrangement to the *Network Service Provider* to modify the *network 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 chapter 3 of these *Rules*, or the *power system* not to comply with the performance standards specified in section 2.2, or the *Network Service Provider* or some other *User* not to comply with their own *protection* requirements specified in the respective sections 2.5 and 3.5, or the *power transfer capability* of the *network* to be reduced.

(c) If the *Network Service Provider* reasonably determines that a setting of a *User's control system* or *protection system* needs to *change* in order; for the *User* to comply with the requirements of chapter 3 of these *Rules*, or for the *power system* to meet the performance standards specified in section 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 section 2.5 or 3.5, as applicable, or for the *power transfer capability* of the *network* 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*.

4.2.8 Commissioning of equipment in existing Nominated IPP facilities

Commissioning of new equipment in existing *Nominated IPP facilities* shall be in accordance with clause 4.1.8 of these *Rules.*

4.2.9 Commissioning of new Nominated IPP facilities

(a) Commissioning of new equipment in new *Nominated IPP facilities* shall be in accordance with clause 4.1.8 of these *Rules* and the remainder of this clause.

(b) For completely new *Nominated IPP facilities a Nominated IPP* must produce a *commissioning plan* which will include, as a minimum:

(1) a detailed *Inspection and Test Plan (ITP)* for the work during the commissioning stage of the project;

(2) a detailed schedule including start, finish and duration times for the work during the commissioning stage of the project; and

(3) details of the proposed commissioning approach for equipment to be used for monitoring the supply reliability and quality of the *Nominated IPP facilities*, which must be included in the *commissioning plan*.

(c) The *Network Service Provider* will nominate specific “Hold” and “Witness” points on the *ITP*.

(d) The *ITP* developed in accordance with subclause 4.2.9(a)(1) must include all the tests, commissioning procedures and acceptance criteria, indicating which of the tests are for which purpose, and must be structured to minimise the risk of disruption of electricity supply to customers. The *ITP* must include and identify:

(1) factory acceptance and on site acceptance tests prior to connecting the *Nominated IPP facilities* to the power system;

(2) the testing and commissioning that will be done in the electrical and mechanical equipment *Nominated IPP’s* works before the equipment is dispatched to the *Nominated IPP power facility* site;

(3) the sequential testing and commissioning steps that will be undertaken at the *Nominated IPP facilities* before these are connected to each power system, which is to happen on or before the designated target commissioning date;

(4) the sequential testing and commissioning steps that will be undertaken when the *Nominated IPP facilities* are first connected to each power system, but before performing *reliable operation testing*;

(5) the testing and commissioning that will be carried out after the date of initial *reliable operation* has been established; and

(6) all test data; readings taken, adjustments made, testing and commissioning results, trip conditions, etc must be recorded and maintained.

(e) Consistent with the requirements of subclause 4.2.9(d), all testing and operational proving of the *Nominated IPP facilities* including fuel supply, generating plant and transmission systems, should be undertaken by the *Nominated IPP*, as far as possible, prior to the connection to the respective power system. Further testing thereafter should be minimised until *reliable operation testing* of the *Nominated IPP facilities* has been completed.

(f) Any additional testing and commissioning required by the *Nominated IPP* for their own purposes must be concluded before the *Nominated IPP facilities* are connected to the power system, or after the satisfactory completion of all *reliable operation* tests.

(g) A *Nominated IPP* must prepare and present the *commissioning plan* to the *Network Service Provider's* designated representative in sufficient time for it to be considered and approved*,* and to allow the *Network Service Provider's* designated representative to be available for any or all tests. All subsequent significant changes to the *Nominated IPP's commissioning plan* must also be approved by the *Network Service Provider* before they are implemented.

NOTE: The *Nominated IPP* must demonstrate to the *Network Service Provider's* reasonable satisfaction that the risk of supply interruptions and out of limit events (specified in clause 3.8.6) after connection to the power system has been minimised. The factory acceptance and on site testing and commissioning before both connection and commencement of *reliable operation testing* must be sufficient to ensure the proper performance of the *Nominated IPP facilities* to deliver electricity in accordance with the power system performance standards specified in these *Rules*.

(h) A *Nominated IPP* must test and prove the *reliable operation* of the *Nominated IPP facilities* switchboard including all synchronising, metering and protection equipment before the *Nominated IPP facilities* are connected to the power system.

(i) A *Nominated IPP* must also perform testing to confirm phase rotation and phase continuity within the distribution system prior to any change-over.

4.3 Disconnection and Reconnection

4.3.1 General

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

(b) The *Network Service Provider* may *disconnect Users* if the *network* is operating outside the permissible limits.

4.3.2 Voluntary Disconnection

(a) Unless agreed otherwise and specified in a *connection agreement*, a *User* must give to the *Network Service Provider* notice in writing of its intention to *disconnect* a *facility* permanently from a *connection point*.

(b) A *User* is entitled, subject to the terms of the relevant *connection agreement*, to require voluntary permanent *disconnection* of its *equipment* from the *power system*, in which case appropriate operating procedures necessary to ensure that the *disconnection* will not threaten *power system security* must be implemented in accordance with clause 4.3.3.

4.3.3 Disconnecting Procedures

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

(b) The *Network Service Provider* must notify other *Users* if it reasonably believes that their rights under a *connection agreement* will be adversely affected by the implementation of the procedures for *disconnection* agreed under subclause 4.3.3(a). The *Network Service Provider* and the *User* and, where applicable, other affected *Users* must negotiate any amendments to the procedures for *disconnection* or the relevant *connection agreements* that may be required.

(c) Any *disconnection* procedures agreed to or determined under subclause 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* may *disconnect* a *User's* facilities from the *network* or otherwise curtail the provision of services in respect of a *connection point*:

(1) in accordance with subclause 4.1.3(f);

(2) in accordance with clause 4.3.5;

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

(4) for safety reasons where the *Network Service Provider* considers that the connection of the *User's* facilities may create a serious hazard to people or property;

(5) in accordance with the provisions of any *Act* or Regulation; or

(6) in accordance with the *User's connection agreement*.

NOTE:	*Disconnection* in accordance with subclause 4.3.4(a)(5) could occur, for example, if the *Network Service Provider* becomes aware that *a User's* earthing arrangements have been *changed* to the extent that they may no longer meet the requirements of subclause 3.6.8(e).

(b) In all cases of *disconnection* by the *Network Service Provider* during an emergency in accordance with clause 4.3.6, the *Network Service Provider* must provide a report to the *User* advising of the circumstances requiring such action.

4.3.5 Curtailment to Undertake Works

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

(1) to carry out planned *augmentation* or maintenance to the *network*; or

(2) to carry out unplanned maintenance to the *network* 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 *network* that affects the *Network Service Provider's* ability to provide services at that *connection point*; or

(4) if an event:

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

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

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

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

(b) The *Network Service Provider* must keep the extent and duration of any curtailment under subclause 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 subclause 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 subclause 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* 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*, 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* as applicable, it is not appropriate to follow the procedure set out in subclause 4.3.6(a) because action is urgently required as a result of a threat to safety of persons, hazard to *equipment* or a threat to *power system security*.

4.3.7 Obligation to Reconnect

The *Network Service Provider* must reconnect a *User's facilities* to a *network* as soon as practicable:

(a) if the breach of the these *Rules* or a *connection agreement* giving rise to the *disconnection* has been remedied; or

(b) 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* that the breach will not re-occur.

5 TRANSMISSION AND DISTRIBUTION SYSTEM OPERATION AND COORDINATION

5.1 Application

This chapter applies to, and defines obligations for, the *Network Service Provider* and all *Users*, and 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*;

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

(c) to establish the operational requirements for *Nominated IPP*s.

5.2 Power System Operation Co-Ordination Responsibilities and Obligations

5.2.1 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* and *medium 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* 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 *constraints* of all plant and *equipment connected* to the *network* on the operation of the *power system*;

(d) subject to clause 5.2.2, 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*.

5.2.2 The Network Service Provider's Obligations

(a) The *Network Service Provider* must, through the provision of appropriate information to *Users* (to the extent permitted by law and under these *Rules*), fulfil its *network* 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 commercial decisions related to open access to the *Network Service Provider's network* 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* so as to ensure that the system performance standards as specified in clause 2.2.2 are met.

(d) When informed by *a Nominated IPP* , in accordance with subclause 5.2.3(i), of an event that may limit supply, the *Network Service Provider* must determine if there is a need to initiate plans to reduce customer loads to manage the system to minimise the impact of the supply limitation.

(e) The *Network Service Provider* must advise the *Nominated IPP* of unusual customer loads that will require special consideration when *dispatching* the *Nominated IPP facilities*. The *Network Service Provider* will also arrange for those customers to advise both the *Nominated IPP* and the *Network Service Provider* of their load requirements with sufficient notice to allow the *Nominated IPP* to plan the *dispatch* of its *generating units.*

(f) The *Network Service Provider* must advise the *Nominated IPP* of any forced outage or event on the *Nominated IPP supplied power system* that will affect the ability to supply *active or reactive power* to *Users* and must coordinate the restoration of supply to *Users* and the restoration of normal *power system* operation with the *Nominated IPP*.

5.2.3 User Obligations

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

(b) A *User* must co-operate with any review of operating incidents undertaken by the *Network Service Provider* under clause 5.6.3.

(c) A *User* must co-operate with and assist the *Network Service Provider* in the proper discharge of the *network* 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*.

(e) A *User* must notify 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 3.3.4.4.

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

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

(h) A *Nominated IPP* must monitor the sent-out demand on a continuous basis and *dispatch generating units* to deliver the electricity at the level of quality necessary to satisfy the power system performance standards specified in section 2.2 and contracted reliability requirements.

(i) The *Nominated IPP* must advise the *Network Service Provider* of every event within the *Nominated IPP's facilities* that may result in the electricity supply being limited below the contracted maximum demand.

(j) The *Nominated IPP* must advise the *Network Service Provider* of any forced outage or *equipment* failure within the *Nominated IPP facilities* that has or may result in a failure to supply *active or reactive power* to any *network Users* immediately after the event or incident has been made safe.

(k) Following any forced outage or *equipment* failure as specified in subclause 5.2.3(j), the *Nominated IPP* must confer and coordinate with the *Network Service Provider* all activities needed to isolate and repair the faulted *equipment* and then restore the supply of *active power*.

(l) Both the *Network Service Provider* and the *Nominated IPP* shall determine and make available to the other all information about the event and the system that will allow the cause of the event to be determined and initiatives taken to eliminate or, as a minimum, reduce the probability of the event occurring again.

(m) The *Network Service Provider* and the *Nominated IPP* shall develop together and agree on all public statements that either may make which in any way refer to or impact on the safety of the public or the supply reliability.

5.3 Control of Transmission and Distribution System Voltages

5.3.1 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 *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 chapter 2.

(e) In order to meet the requirements of subclause 5.3.1(d), the *Network Service Provider* must arrange the provision of *reactive power* facilities and *power system voltage* stabilising facilities through:

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

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

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

(f) *Reactive power* facilities arranged under subclause 5.3.1(e) may include any one or more of:

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

(2) *synchronous condensers* (*compensators*);

(3) *static VAr compensators* (SVC);

(4) *static synchronous compensators* (STATCOM);

(5) *shunt capacitors*;

(6) *shunt reactors*; and

(7) series capacitors.

5.3.2 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*.

5.3.3 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*.

5.4 Protection of Power System Equipment

5.4.1 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 *Network Service Provider* must ensure that the fault levels determined under subclause 5.4.1(a) must be available to a *User*, on request, and other information as will allow the *User* to determine the maximum fault level at any of the *User's connection points*.

5.4.2 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 section 4.1.

5.4.3 Power Transfer limits

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

5.4.4 Partial Outage of Power Protection Systems

(a) Where there is an *outage* of one *protection scheme* of a *transmission element*, the *Network Service Provider* must determine 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 any affected *Users* immediately this action is undertaken.

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

5.5 Power System Stability Coordination

5.5.1 Stability Analysis Coordination

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.

5.5.2 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*.

5.6 Power System Security Operation and Coordination

5.6.1 User's Advice

(a) A *User* must promptly advise the *Network Service Provider* if the *User* becomes aware of any circumstance, including any defect in, or mal-operation of, any *protection* or *control system*, which could be expected to adversely affect the secure operation of the *power system*.

(b) If the *Network Service Provider* considers the circumstances advised to it under subclause 5.6.1(a) to be a threat to *power system security*, the *Network Service*

Provider 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 subclause 5.6.1(b).

5.6.2 Managing Electricity Supply Shortfall Events

It is the responsibility of the *Network Service Provider* to manage *supply* shortfall events arising from a shortage of *generation* or from multiple *contingency events* on those parts of the *transmission system* under its direct control. However *supply* shortfall events may also occur as a result of *contingency events* arising within those parts of the *network* 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 subclause 5.2.1(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 anyone or more of the following:

(1) recall of:

(A) a *distribution equipment outage*;

(B) a *transmission equipment outage.*

(2) *disconnect* one or more *load connection points* as the *Network Service Provider* considers necessary; or

(3) direct a *User* to take such steps as are reasonable to reduce its *load* immediately. Any temporary *load* reduction must be such that preference in *supply* is given, where necessary, to domestic *Consumers*, then commercial *Consumers* and finally industrial *Consumers*.

(b) A *User* must comply with a *direction* given under subclause 5.6.2(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.

5.6.3 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.

(b) A *User* must cooperate 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* 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* to take that action.

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

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

(f) Events specified in subclause 5.2.2(j) or subclause 5.2.3(j) shall be reviewed by the *Network Service Provider* and the *Nominated IPP* to determine the cause of the event and identify initiatives that should be taken to eliminate or as a minimum reduce the probability of the event occurring again.

(g) The *Nominated IPP* must cooperate with any review conducted in accordance with subclause 5.6.3(f) and provide the *Network Service Provider* with any information it has regarding the event.

5.6.4 Nominated IPP Blackstart Capability

(a) The *Nominated IPP* must install, test and maintain the blackstart capability such that restoration of supplies to the *Nominated IPP supplied power system* can be completed within 5 minutes of a forced outage that shuts down the *Nominated IPP's* supply of *active power* to the *power system*.

(b) The *Nominated IPP* must advise the *Network Service Provider* of any total system shut down and restart their *generating plant*. The restoration of the supply of *active power* to the *Nominated IPP supplied power system* shall be coordinated with the *Network Service Provider*.

5.6.5 Nominated IPP Performance During Emergencies

(c) The *Network Service Provider* is responsible for the management of the *Nominated IPP supplied power system* during an emergency and will comply with its responsibilities to emergency services agencies.

(d) The *Nominated IPP* must provide the *Network Service Provider* any relevant information or data on its facilities to understand their ability to respond during an emergency.

(e) To manage emergencies the *Nominated IPP* and the *Network Service Provider* must exchange check sheets to ensure both parties are fully informed of the level of preparedness.

> **NOTE:** The detail of the check sheets will be subject to continuous development between the parties over time as technology and customer patterns change.

(f) The *Network Service Provider* shall advise and direct the *Nominated IPP* on the curtailment of *active power* supplied to *Users* or their disconnection during emergencies such as cyclones where this is required to effectively manage the *power system*.

(g) The *Nominated IPP* must exercise due care for the safety of its employees and the public, and the serviceability of its power plant during emergencies. The *Nominated IPP* must advise the *Network Service Provider* in good time of any action it intends or plans that may or will affect the supply of active power to *Users*.

5.7 Operations and Maintenance Planning

(a) On or before 1 July and 1 January each year, a *User*, where so requested by the *Network Service Provider*, must provide to the *Network Service Provider*:

(1) a maintenance schedule in respect of the *equipment* and *equipment connected* at each of its *connection points* for the following *financial year*; and

(2) a non-binding indicative planned maintenance plan in respect of the *equipment* and *equipment connected* at each of its *connection points* for each of the 2 *financial years* following the *financial year* to which the maintenance schedule provided under subclause 5.7(a)(1) relates.

(b) A *User* must provide the *Network Service Provider* with any information that the *Network Service Provider* requests concerning maintenance of *equipment* and *equipment connected* at the *User's connection points*.

(c) A *User* must ensure that a maintenance schedule provided by the *User* under subclause 5.7(a)(1) is complied with, unless otherwise agreed with the *Network Service Provider*.

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

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

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

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

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

(e) If a *User* becomes aware that a maintenance schedule provided by the *User* under subclause 5.7(a)(1) in respect of one of its *connection points* will not be complied with, then the *User* must promptly notify the *Network Service Provider*.

(f) A *Nominated IPP* must plan all maintenance of its *equipment* and other activities requiring the switching of *loads* or the isolation of parts of the *network* and communicate these plans to the *Network Service Provider* so that those activities can be coordinated with *network* maintenance and operations.

(g) If the *Nominated IPP* requires the switching of *network equipment* to enable planned maintenance, it must prepare switching programs that adhere to a format specified by the *Network Service Provider* and submit the program to the *Network Service Provider.*

(h) Any switching of the *Nominated IPP*'s equipment must be completed by trained operators.

(i) The *Network Service Provider* shall plan and coordinate all maintenance and other activities requiring the switching of loads or the isolation of parts of the system with the *Nominated IPP*.

(j) The *Network Service Provider* will exercise overall management of switching procedures which require switching of *network equipment*, or impact in any way on the reliability of the supply to other *network Users*.

(k) The *Network Service Provider* shall use best endeavours to avoid switching loads that are greater than 30% of the total *Nominated IPP supplied power system load* at the time. Where this is unavoidable the *Network Service Provider* must:

(1) only switch loads greater than 30% of the total *Nominated IPP supplied power system load* by prior arrangement with the *Nominated IPP; and*

(2) provide adequate time prior to any switching of the *load* for the *Nominated IPP* to arrange generating requirements to meet the proposed load changes while still achieving the *Nominated IPP's* contracted reliability requirements and the quality of supply requirements specified in section 2.2.

(l) The *Network Service Provider*'s access permit system shall be used to manage the isolation, proving dead and earthing of all equipment which affects the *Nominated IPP's* interface with the *connection point* or which requires the *Network Service Provide* to manage or switch *network equipment*.

5.8 Power System Operating Procedures

5.8.1 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 *network* in accordance with the requirements of these *Rules*, any applicable *connection 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 section 2.2. A *User* must comply with any such *direction*.

5.9 Power System Operation Support

5.9.1 Remote Control and Monitoring Devices

All remote control, operational metering and monitoring devices and local circuits as described in chapter 3 must be installed, operated and maintained by a *User* in accordance with the standards and protocols determined and advised by the *Network Service Provider*.

5.9.2 Power system Operational Communication Facilities

(a) *Users* must advise the *Network Service Provider* of its requirements for the giving and receiving of *operational communications* in relation to each of its facilities. 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) A *User* must maintain the speech communication channel installed in accordance with subclause 3.3.4.3(c) or subclause 3.4.9(d) in good repair and must investigate any fault within 4 hours, or as otherwise agreed with the *Network Service Provider*, of that fault being identified and must repair or procure the repair of faults promptly.

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

(d) The *Network Service Provider* must, where necessary for the operation of the *transmission* and *distribution system*, advise *Users* of nominated persons for the purposes of giving or receiving *operational communications*.

(e) Contact details to be provided by the *Network Service Provider* in accordance with subclause 5.9.2(d) include position, telephone numbers, a facsimile number and an electronic mail address.

5.9.3 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 5.9.2 as having been given by or to the *User* or the *Network Service Provider*, as the case requires.

5.9.4 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 logbook 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 subclause 5.9.4(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 subclause 5.9.4(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.

5.10 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* has the meaning given in the *Act*, unless redefined in the table below.

Term	Description
Access Code	The *Electricity Networks Access Code (2004) (WA)*
accumulated synchronous time error	The difference between Western Australia Standard Time and the time measured by integrating the instantaneous operating *frequency* of the *power system*.
Act	The *Electricity Industry Act (2004) (WA).*
active energy	A measure of electrical *energy* flow, being the time integral of the product of *voltage* and the in-phase component of current flow across a *connection point*, expressed in watt hours (Wh) and multiples thereof
active power	The rate at which *active energy* is transferred.
agreed capability	In relation to a *connection point*, the capability to receive or send out *active power* and *reactive power* for that *connection point* determined in accordance with the relevant *connection agreement*.
ancillary service(s)	Services for: *voltage* control, *control system* services, spinning *reserve* and post-trip management.
applicant	Means a person (who may be a *User*) who has lodged a *connection application*
augment*, augmented, *augmentation	In relation to a *network,* means an increase in the capability of the *network* to provide services.
***Australian Standard* (*AS*)**	The edition of a standard publication by Standards Australia (Standards Association of Australia) as at the date specified in the relevant clause or, where no date is specified, the most recent edition.
automatic reclose equipment	In relation to a *transmission or distribution 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 or distribution line*.

Term	Description
back-up protection system	A *protection system* intended to supplement the *main protection system* in case the latter does not operate correctly, or to deal with faults in those parts of the *power system* that are not readily included in the operating zone of the *main protection system*. A *back-up protection system* may use the same circuit breakers as a *main protection system* and a *protection scheme* forming part of a *backup protection system* may be incorporated in the same *protection apparatus* as the *protection schemes* comprising the *main protection system*.
basic EG connection	A connection to the low voltage distribution system meeting the requirements specified in the "Basic EG Connection Technical Requirements" published by the *Network Service Provider*.
black start-up equipment	The *equipment* required to provide a *generating unit* with the ability to start and synchronise without using electricity supplied from the *power system*.
busbar	A common *connection point* in a *power station substation* or a *network substation*.
business day	Means a day that is not a Saturday, Sunday or public holiday throughout Western Australia
capacitor bank	A type of electrical *equipment* used to generate *reactive power* and therefore support *voltage* levels on *transmission* 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 over*load*ing) arising or made worse as a result of the event preceding it.
category 1 step loads	Changes in load (being any increase or decrease in load within a 60 second period) resulting from loads being connected or disconnected, or renewable energy fluctuations, during normal operations, which do not exceed the maximum of: (a) an increase or decrease of between 10% and 30% of the system load present immediately prior to the step load change occurring, or (b) as specified in the *connection agreement*.
category 2 step loads	Changes in load (being an increase or decrease in load within a 60 second period) that are not *Category 1 step loads* and do not exceed either: (a) an increase of greater than 30% of the system load present immediately prior to the step load change occurring; or (b) a reduction of 100% of the system load present on the system immediately prior to the step load change occurring.
Change	Includes amendment, alteration, addition or deletion.

Term	Description
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.
commissioning plan	A plan developed by *a Nominated IPP* consistent with subclause 4.2.9(a) of these *Rules* for the purpose of commissioning new *Nominated IPP facilities*.
***Commitment** (in relation to testing of *generating units)*	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 *network*, by direct or indirect connection, so as to have an impact on *power system security*, *reliability* and *quality of supply*.
connection agreement	An agreement or other arrangement between the *Network Service Provider* and a *User*, that specifies the technical requirements that apply in relation to the connection of a *User's equipment* to the *network.*
connection application	An application to a *Network Service Provider* from a *User* requesting a *Connection Agreement*.
connection asset	All of the *network* assets that are used only in order to transfer electricity to or from the *connection point*.
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 *network*, *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*.

Term	Description
control system	The means of monitoring and controlling the operation of the *power system* or *equipment* including *generating units connected* to a *network*.
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	In respect of a *connection point*, means all of those persons who engage in one or more of the activities of owning, controlling and operating plant or *equipment* transferring electricity to or taking electricity from the *network.*
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* of one of the following types: (a) a three-phase to earth fault cleared by *disconnection* of the faulted component, with the fastest *main protection scheme* out of service; (b) a single-phase to earth fault cleared by the *disconnection* of the faulted component, with the fastest *main protection scheme* out of service; (c) a single-phase to earth fault cleared after unsuccessful high-speed single-phase auto-reclosure onto a persistent fault; (d) a single-phase to earth *small zone fault* or a single-phase to earth fault followed by a *circuit breaker failure*, in either case cleared by the operation of the fastest available *protection scheme*; or (e) a sudden *disconnection* of a system component, e.g. a *transmission line* or *generation unit*
critical fault clearance time	The maximum *total fault clearance time* that the *power system* can withstand without one or both of the following conditions arising: (a) instability; and (b) unacceptable disturbance of *power system voltage* or *frequency*.
current rating	The maximum current that may be permitted to flow (under defined conditions) through a *transmission* or *distribution* line or other item of *equipment* that forms part of a *power system*.

Term	Description
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.
Dampier 33 kV systems	The 33 kV network covering: (a) Dampier 33 kV interconnectors between Horizon Power and Rio Tinto systems (DMP61 and DMP62); (b) The Dampier 33 kV substation.
damping ratio	A standard mathematical parameter that characterises the shape of a damped sine wave.
direction	A *requirement* issued by the *Network Service Provider* to any *User* requiring the *User* to do any act or thing which the *Network Service Provider* considers necessary to maintain or re-establish *power system security* or to maintain or re-establish the *power system* in a *reliable* operating state in accordance with these *Rules*.
disconnect	The operation of switching *equipment* or other action so as to prevent the flow of electricity at a *connection point*.
dispatch	The act of committing to service all or part of the *generation* available from a *generating unit*.
dispatchable generating unit	A *generating unit* that, in its satisfactory normal operating state, is capable of closely controlling its real power output.
distribution	The functions performed by a *distribution system*, including conveying, transferring or permitting the passage of electricity.
distribution feeder	A *medium 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 *voltage*s of less than 66 kV and which form part of the *Pilbara Grid* or *Non Interconnected Systems* owned and/or operated by the Regional Electricity-*Network*s Corporation (trading as Horizon Power),
dynamic performance	The response and behaviour of *networks* and *facilities* which are *connected* to the *network*s 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*.

Term	Description
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	*Active energy* or *reactive energy*, or both.
energy storage facility	A device consisting of 'storage works' as defined in the *Act*. [The definition in the *Act* as of 7 February 2021 was: ***storage works*** means any wires, apparatus, equipment, plant or buildings used, or to be used, for, or in connection with, or to control, a storage activity] When discharging *active power*, *electricity storage facilities* are considered as *generation* and must meet the relevant clauses of the *Rules*. When consuming *active power*, *electricity storage facilities* are considered as *load* and must meet the relevant clauses of the *Rules*. For the avoidance of doubt, non-controllable energy storage such as a synchronous compensator or flywheel are not considered *electricity storage facilities*.
equipment	A device used in generating, transmitting, distributing 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).
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.

Term	Description
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 in section 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	Any person (including a *User* or the *Network Service Provider*) 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	Means the exercise of that degree of skill, diligence, prudence and foresight that a skilled and experienced person would reasonably and ordinarily exercise under comparable conditions and circumstances consistent with applicable *written laws* and *statutory instruments* and applicable recognised codes, standards and guidelines.
Gradual bumpless transfer	The make-before-break transfer of a *load* between *the distribution system* and an islanded *generating unit* (or vice versa) where the time for which the *generating unit* is operated in parallel with the *distribution system* is limited to less than 60 seconds.
halving time	The elapsed time required for the magnitude of a damped sine wave to reach half its initial value.

Term	Description
high voltage	Any nominal *voltage at or* above 35 kV.
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.
inspection and test plan (ITP)	A plan developed by *a Nominated IPP* consistent with subclause 4.2.9(a)(1) of these *Rules* and which meets the requirements in subclause 4.2.9(d) of these *Rules*. An *ITP* covers the work during the commissioning stage of a new *Nominated IPP power facility*.
interconnection	A *transmission line* or group of *transmission lines* that connects the *transmission system*s in adjacent *regions*.
inverter connected energy system	A system comprising one or more inverters together with one or more energy sources (which may include batteries for energy storage). For the avoidance of doubt, *inverter connected energy systems* may include inverter connected energy storage and inverter connected generation.
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 transfer* at a defined instant at a specified ,point on the *network* as the case requires.
load shedding	Reducing or *disconnecting load* from the *power system*.
low voltage	Any nominal *voltage* of 1 kV and below

Term	Description
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*.
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*.
medium voltage	Any nominal *voltage* above 1 kV and less than 35 kV
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)* (W A).
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	Means the *Network Service Provider's transmission system* and the *distribution system* collectively, and owned, operated or controlled by that *Network Service Provider*.
Network Service Provider	The meaning given to it in subclause 1.3(a) and currently refers only to Horizon Power.

Term	Description
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 section 5.10.
Nominated independent power producer (Nominated IPP)	A *User* (typically a *Generator*) that is nominated by the *Network Service Provider* to be the primary *voltage* and *frequency* source for a *non interconnected system* and contracted to achieve the power system performance standards specified in these *Rules.*
Nominated IPP facilities	The facilities operated by *a Nominated IPP*.
Nominated IPP supplied power system	A *non interconnected system* for which *a Nominated IPP* is contracted to meet energy requirements and regulate the *voltage* and *frequency*.
Non interconnected Systems	The isolated networks in East Kimberley (Kalumburu, Wyndham, Kununurra, Lake Argyle, Warmun and Halls Creek), West Kimberley (Derby, Camballin/Looma, Fitzroy Crossing, Yungngora, Bidyadanga, Broome, Beagle Bay, Djarindjin/Lombadina and Ardyaloon), East Pilbara (Marble Bar and Nullagine), West Pilbara (Onslow) Gascoyne/Midwest (Exmouth, Coral bay, Carnarvon, Denham, Gascoyne Junction, Meekatharra, Cue, Mt Magnet, Yalgoo, Wiluna, Sandstone, Laverton, Leonora and Menzies) and Esperance (Esperance, Norseman and Hopetoun).
non-dispatchable generating unit	A *generating unit* that in its satisfactory normal operating state is not capable of closely controlling its real power output.
North West Interconnected System* or *NWIS	See *Pilbara Grid*
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*.
Pilbara Grid	The interconnected *network* located in the Pilbara *region* of the state of Western Australia.

Term	Description
Pilbara Harmonised Technical Rules	The rules in Appendix 5 of the *Pilbara Network Rules* made under the *Act*.
Pilbara ISO	The Pilbara ISO as defined in regulation 14 of the *Electricity Industry (Pilbara Networks) Regulations 2021*.
Pilbara Network Access Code	The Pilbara Network Access Code in force under Part 8A, Division 2 of the *Act.*
Pilbara Network Rules	The Pilbara Network Rules in force under Part 8A, Division 3 of the *Act.*
point of common coupling	The point on the *network* at which Horizon Power requires compliance with the Technical Rules subclauses 2.3.3(a) and 2.3.4(a). Under normal circumstances this compliance is required at the connection point but Horizon Power may, at its sole discretion allow the "point of common coupling" to be at a point on the network upstream from the connection point, where it is reasonable to do so in accordance with good electricity industry practice.
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 *transformer*s, *substations* and the *power station control centre*.
power system	The electric *power system* constituted by the *Pilbara Grid* and its *connected generation* and *loads*, operated as an integrated system and *Non Interconnected System distribution systems* owned and operated by the Regional Corporation trading as Horizon Power.
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 section 5.8.
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 chapter 5 and the operating procedures of the *Network Service Provider*
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*.

Term	Description
power transfer capability	The maximum permitted *power transfer* through a *network* or part thereof.
pre-emptive load shedding scheme	Pre-planned scheme for reducing or *disconnecting load* from the *power system*.
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 *network*.
protection system	A system designed to *disconnect* faulted *primary equipment* from the *network*, which includes one or more *protection schemes* and which also includes the *primary equipment* used to effect the *disconnection*.
quality of supply	With respect to electricity, technical attributes to a standard set out in section 2.2, unless otherwise stated in these *Rules* or the relevant *connection agreement*.
rapid bumpless transfer	The make-before-break transfer of a *load* between *the distribution system* and an islanded *generating unit* (or vice versa) where the time for which the *generating unit* is operated in parallel with the *distribution system* is limited to less than 1 second.
reactive energy	A measure, in VAr hours (VArh) of the alternating exchange of stored *energy* in inductors and capacitors, which is the time-integral of the product of *voltage* and the out-of-phase component of current flow across a *connection point*.
reactive equipment	That *equipment* which is normally provided specifically to be capable of providing or absorbing *reactive power*, and includes the *equipment* identified in subclause 5.3.1(f).

Term	Description
reactive power	The rate at which *reactive energy* is transferred, measured in VArs. *Reactive power* is a necessary component of alternating current electricity which is separate from *active power* and is predominantly consumed in the creation of magnetic fields in motors and *transformers* and produced by *equipment* such as: (a) alternating current *generating units*; (b) capacitors, including the capacitive effect of parallel *transmission* wires; (c) *synchronous condensers*. *Reactive power* is obtained from a combination of static and dynamic sources. Static sources include, for example, *reactors* and *capacitor bank*s, and the charging current of *transmission lines*. Dynamic sources include, for example, synchronous machines, operating as *generating units* or *synchronous compensators*, and *static VAr compensators*.
reactive power capability	The maximum rate at which *reactive energy* may be transferred from a *generating unit* to a *connection point* as specified in the relevant *connection agreement*.
reactive power reserve	Unutilised sources of *reactive power* arranged to be available to cater for the possibility of the unavailability of another source of *reactive power* or increased requirements for *reactive power*.
reactor	A device, similar to a *transformer*, arranged to be *connected* into the *network* 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.

Term	Description
reliable operation	For *a Nominated IPP*, as defined in the relevant *connection agreement.*
reliable operation testing	For *a Nominated IPP*, the set of tests as agreed with the *Network Service Provider* to demonstrate the reliable operation of the *Nominated IPP facility*.
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 Regional Electricity-*Network*s Corporation (trading as Horizon Power).
Rules commencement date	The *Rules commencement date* is 1 July 2007.
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*.

Term	Description
scheduled generating unit	A *generating unit* which is *dispatched* by the *Network Service Provider.*
secondary equipment	*Equipment* within a *facility* or the electricity *network*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 service to *Users*. As it relates to the robustness of the system to imminent disturbances, it depends on the system operating condition as well as the contingent probability of disturbances.
sensitivity	In relation to *protection schemes*, has the meaning in clause 2.5.6.
service provider	In relation to a *network,* means a person who owns or operates the *network.*
shunt capacitor	A type of *equipment connected* to a *network* to generate *reactive power*.
shunt reactor	A type of *equipment connected* to a *network* to absorb *reactive power*.
single contingency	In respect of a *transmission system*, a sequence of related events which result in the removal from service of one *transmission line*, *transformer* or other item of *equipment*. The sequence of events may include the application and clearance of a fault of defined severity.
small disturbance	A disturbance sufficiently small to permit the linearization of system equations for the purposes of analysis. The resulting system response involves small excursions of system variables from their pre-disturbance values. *Small disturbances* may be caused by routine switching (for example, line or capacitor), *transformer* tap *changes*, *generating unit* AVR set point *changes*, *changes* in the *connected load*, etc.
small disturbance rotor angle stability	The ability of the *power system* to maintain *synchronism* under *small disturbances*.
small use customer	A *Consumer* that consumes less than 160 MWh of electricity per annum.
small zone fault	A fault which occurs on an area of *equipment* that is within the zone of detection of a *protection scheme*, but for which not all contributions to the fault will be cleared by the circuit breaker(s) tripped by that *protection scheme*. For example, a fault in the area of *equipment* between a *current transformer* and a circuit breaker, fed from the *current transformer* side, may be a *small zone fault*.

Term	Description
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.
static synchronous compensator (STATCOM)	A device provided on a *network* 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 *network.*
static VAr compensator	A device provided on a *network* 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 *network*.
statutory instruments	Means all relevant instruments made under a *written law* including all *directions*, notices, orders and other instruments given or made under a *written law*.
Substation	A *facility* at which lines are switched for operational purposes, and which may include one or more *transformers* so that some *connected* lines operate at different nominal *voltages* to others.
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 *network* rotate at the same average speed, resulting in controlled sharing of the transfer of power. Loss of *synchronism* causes uncontrolled transfers of power between machine groups, causing severe and widespread disturbances of *supply* to *Users*, *disconnection* of *transmission lines*, possible damage to synchronous machines and system shutdown.
synchronous condenser or synchronous compensator	An item of *equipment*, similar in construction to a *generating unit* of the *synchronous generating unit* category, which operates at the equivalent speed of the *frequency* of the *power system*, provided specifically to generate or absorb *reactive power* through the adjustment of rotor current.
synchronous generating unit	The alternating current *generating units* which operate at the equivalent speed of the *frequency* of the *power system* in its normal operating state.

Term	Description
synchronous generating unit voltage control	The automatic *voltage control system* of a *generating unit* of the *synchronous generating unit* category which *changes* the output *voltage* of the *generating unit* through the adjustment of the *generating unit* rotor current and effectively *changes* the *reactive power* output from that *generating unit*.
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 *network* 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 minimum	The minimum continuous *active power* output of a *generating unit*.
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 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), but excluding busbars.

Term	Description
transmission equipment	The *equipment* associated with the function or operation of a *transmission line* or an associated *substation*, which may include *transformers*, circuit breakers, *reactive equipment* and *monitoring equipment* and control *equipment*.
transmission line	A power line that is part of a *transmission system*.
transmission system	Any apparatus*, equipment*, plant or buildings used, or to be used, for, or in connection with, the transportation of electricity at nominal *voltage*s of 66 kV or higher, and which forms part of the *Pilbara Grid*. For the avoidance of doubt the *transmission system* includes equipment such as static *reactive power* compensators, which is operated at *voltage*s below 66 kV, provided that the primary purpose of this *equipment* is to support the transportation of *electricity* at *voltage*s of 66 kV or higher.
trip circuit supervision	A function incorporated within a *protection scheme* that results in alarming for the loss of integrity of the *protection scheme's* trip circuit. *Trip circuit supervision* supervises a *protection scheme*'s trip *supply* together with the integrity of associated wiring, cabling and circuit breaker trip coil.
trip supply supervision	A function incorporated within a *protection scheme* that, results in alarming for loss of trip *supply*.
turbine control system	The automatic *control system* which regulates the speed and power output of a *generating unit* through the control of the rate of entry into the *generating unit* of the primary *energy* input (for example, steam, gas or water).
two fully independent protection schemes of differing principle	*Protection schemes* having *differing principle*s of operation and which, in combination, provide dependable detection of faults on the protected *primary equipment* and operate within a specified time, despite any single failure to operate of the *secondary equipment*. To achieve this, complete *secondary equipment* redundancy is required, including *current transformer* and *voltage transformer* secondaries, auxiliary supplies, signalling systems, cabling, wiring, and circuit breaker trip coils. Auxiliary supplies include DC supplies for *protection* purposes. Therefore, to satisfy the redundancy requirements, each *protection scheme* would need to have its own independent battery and battery charger system *supplying* all that *protection scheme*'s trip functions. In addition the relays of each *protection scheme* must be grouped in separate physical locations (which need not be in different panels). Furthermore the two *protection schemes* must either use different methods of operation or, alternatively, have been designed and manufactured by different organisations.
User	Has the meaning given in subclause 1.3(a)(2).

Term	Description
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 (WAER)	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/
WA Service and Installation Requirements (WASIR)	The Western Australian Service and Installation Requirements as published by Western Power and Horizon Power.
wind farm	A *power station* consisting of one or more wind powered *generating units*.
written law	Means: (a) All Western Australian *Acts* and all Western Australian subsidiary legislation for the time being in force; and (b) All Commonwealth *Acts* and all Commonwealth “subsidiary legislation” for the time being in force, where the term subsidiary legislation has the meaning given to it under the *Interpretation Act (1984)*, if “Commonwealth *Act* “were substituted for ‘*written law*”.
zone substation	A *substation* that transforms electricity from a *transmission system voltage* to a *distribution system voltage*.

ATTACHMENT 2 INTERPRETATION

In these *Rules*, headings and captions are for convenience only and do not affect interpretation and, unless the contrary intention appears from the context, and subject to the *Act*, these *Rules* must be interpreted in accordance with the following *rules* of interpretation:

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

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

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

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

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

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

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

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

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

ATTACHMENT 3 SUMMARY OF TECHNICAL DETAILS TO SUPPORT APPLICATION FOR CONNECTION

A3.1 Various sections of the *Code* require that *Users* submit technical data to the *Network Service Provider*. This Attachment 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 or connection agreement*.

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* or *connection application*, to allow the *Network Service Provider* to prepare an offer of terms for a *connection agreement* and to assess the requirement for, and effect of, *transmission and distribution system augmentation* or *extension* options. Such data is normally limited to the items denoted as Standard Planning Data (S) in the technical data schedules in Attachment 4 to Attachment 10.

the *Network Service Provider* may, in cases where there is doubt as to the viability of a proposal, require the submission of other data before making an access offer to connect or to amend an *access contract* or *connection agreement*.

Registered system planning data

This is the class of data which will be included in the *access contract* or *connection agreement* signed by both parties. It consists of the preliminary system planning data plus those items denoted in the attached schedules as Detailed Planning Data (D).The latter must be submitted by the *User* in time for inclusion in the *access contract* or *connection agreement*.

Registered data

Registered Data consists of data validated and augmented 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 and reports.

A3.4 Attachment 4 to Attachment 14, cover the following data areas:

(a) Attachment 4 –Generating Unit (> 10 MW) Design Data. This comprises large generating unit fixed design parameters.

(b) Attachment 5 – Submission Requirements for Electrical Plant Protection. This comprises design and setting data for protection systems that must coordinate or interface with the protection systems for the transmission and distribution system or that could impact the operation of the transmission and distribution system.

(c) Attachment 6 –Generating unit (> 10 MW) Setting Data. This comprises settings which can be varied by agreement or by direction of the *Network Service Provider*.

(d) Attachment 7 – Transmission system and equipment Technical Data of Equipment at or Near Connection Point. This comprises fixed electrical parameters.

(e) Attachment 8 – Transmission equipment and Apparatus Setting Data. This comprises settings which can be varied by agreement or by direction of the *Network Service Provider*.

(f) Attachment 9 – Load Characteristics at Connection Point. This comprises the estimated parameters of load groups in respect of, for example, harmonic content and response to *frequency* and *voltage* variations.

(g) Attachment 10 – Distribution System Connected Generators up to 10 MW (except inverter-connected generators up to 1000 kVA). This comprises a reduced set of design parameters that the *Network Service Provider* may require for small *power stations* covered by section 3.4 of the *Rules*.

(h) Attachment 11 – Test Schedule for Specific Performance Verification and Model Validation. This comprises a schedule of commissioning and performance tests that the *Network Service Provider* may require for large *generating units* covered by section 3.3 of the *Rules*. Note: these tests may also be required for small *power stations* covered by section 3.4 of the *Rules* where appropriate as determined by the *Network Service Provider*.

(i) Attachment 12 – Testing and Commissioning of Small *Power Stations* (< 10 MW) *Connected* to the *Distribution System*. This comprises a schedule of commissioning and performance tests that the *Network Service Provider* may require for small *power stations* covered by section 3.4 of the *Rules*.

(j) Attachment 13 – Standard Primary Plant Ratings. This comprises ratings requirements to which new primary plant is to be designed and installed.

(k) Attachment 14 – Rating of Overhead Earth Wires, Phase Conductors and Earth Grids. This comprises ratings for overhead earth wires, phase conductors and earth grids at terminal stations and zone substations.

A3.5 A *Generator* that connects a large *generating unit* that is not a *synchronous generating unit* must be given exemption from complying with those parts of schedules in Attachments 4 and 6 that are determined by the *Network Service Provider* to be not relevant to such *generating units*, but must provide the information required by with those parts of the schedules in Attachments 5, 7, 8 and 9 that are relevant to such *generating units*, as determined by the *Network Service Provider*. For this non-*synchronous 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 GENERATING UNIT (>10 MW) DESIGN DATA[1]

Symbol	Data Description	Units	Data Category
	Power station **technical data:**		
	Connection point to *Transmission system*	Text, diagram	S, D
	Nominal *voltage* at *connection point* to *Transmission system*	kV	S
	Total Station Net Maximum Capacity (NMC)	MW (sent out)	S, D, R2
	At *connection point*:		
MSCR	Minimum Short Circuit Ratio:	Numeric ratio	S, D, R1
	The lowest *short circuit ratio* at the *connection point* for which the *generating system*, including its *control systems*: (i) will be commissioned to maintain stable operation; and (ii) has the design capability to maintain stable operation.		
	For the purposes of the above, "*short circuit ratio*" is the synchronous three phase fault level (expressed in MVA) at the *connection point* divided by the rated output of the *generating system* (expressed in MW or MVA) at the *Network Service Provider's* discretion.		
	Maximum 3 phase short circuit infeed calculated by method of *AS* 3851 (1991) (Amendment 1-1992)		
	Symmetrical	kA	S, D
	Asymmetrical	kA	D
	Minimum zero sequence impedance	(a+jb) ohms	D
	Minimum negative sequence impedance	(a+jb) ohms	D
	Individual synchronous generating unit data:		

[1] Where applicable and unless requested otherwise, the data shall be provided at the site specific maximum ambient temperature

Symbol	Data Description	Units	Data Category
	Make		
	Model		
M_{BASE}	Rated MVA	MVA	S, D, R1
P_{SO}	Rated MW (Sent Out)	MW (sent out)	S, D, R1
P_{MAX}	Rated MW (*generated*)	MW (Gen)	D
VT	Nominal Terminal *Voltage*	kV	D, R1
P_{AUX}	Auxiliary *load* at P_{MAX}	MW	S, D, R2
Q_{MAX}	Rated Reactive Output at P_{MAX}	MVAr (sent out)	S, D, R1
P_{MIN}	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
G_{SCR}	Short Circuit Ratio		D, R1
I_{STATOR}	Rated Stator Current	A	D, R1
I_{ROTOR}	Rated Rotor Current at rated MVA and *Power factor*, rated terminal volts and rated speed	A	D,R1
V_{ROTOR}	Rotor *Voltage* at which I_{ROTOR} is achieved	V	D, R1
V_{CEIL}	Rotor *Voltage* capable of being supplied for five seconds at rated speed during field forcing	V	D, R1
ZN	Neutral Earthing Impedance	(a+jb)%[2]	
	•		
	***Generating unit* resistance:**		
RA	Stator Resistance	% on M_{BASE}	S, D, R1, R2

[2] MVA **base must be clearly stated**

Symbol	Data Description	Units	Data Category
RF	Rotor resistance at 20°C	ohms	D, R1
	***Generating unit* sequence impedances (saturated):**		
Z0	Zero Sequence Impedance	(a+jb)% on M_{BASE}	D, R1
Z2	Negative Sequence Impedance	(a+jb)% on M_{BASE}	D, R1

Symbol	Data Description	Units	Data Category
	Generating unit **reactance (saturated):**		
XD'(sat)	Direct Axis Transient Reactance	% on M_{BASE}	D, R1
XD"(sat)	Direct Axis Sub-Transient Reactance	% on M_{BASE}	D, R1
	Generating unit **reactance (unsaturated):**		
XD	Direct Axis Synchronous Reactance	% on M_{BASE}	S, D, R1, R2
XD'	Direct Axis Transient Reactance	% on M_{BASE}	S, D, R1, R2
XD"	Direct Axis Sub-Transient Reactance	% on M_{BASE}	S, D, R1, R2
XQ	Quadrature Axis Synch Reactance	% on M_{BASE}	D, R1, R2
XQ'	Quadrature Axis Transient Reactance	% on M_{BASE}	D, R1, R2
XQ"	Quadrature Axis Sub-Transient Reactance	% on M_{BASE}	D, R1, R2
XL	Stator Leakage Reactance	% on M_{BASE}	D, R1, R2
XO	Zero Sequence Reactance	% on M_{BASE}	D, R1
X2	Negative Sequence Reactance	% on M_{BASE}	D, R1
XP	Potier Reactance	% on M_{BASE}	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

Symbol	Data Description	Units	Data Category
	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	R1
	***Generating unit transformer*:**		
GTW	Number of windings	Text	S, D
GTRn	Rated MVA of each winding	MVA	S, D, R1
GTTRn	Principal tap rated *voltages*	kV/kV	S, D, R1
GTZ1n	Positive Sequence Impedances (each wdg)	(a + jb) % on 100 MVA base	S, D, R1
GTZ2n	Negative Sequence Impedances (each wdg	a + jb) % on 100 MVA base	S, D, R1
GTZOn	Zero Sequence Impedances (each wdg	(a + jb) % on 100 MVA base	S, D, R1
	Tapped Winding	Text, diagram	S, D, R1
GTAPR	Tap Change Range	kV - kV	S, D
GTAPS	Tap Change Step Size	%	D
	Tap Changer Type, On/Off *load*	On/Off	D
	Tap Change Cycle Time	Seconds	D
GTVG	Vector Group	Diagram	S, D
	Earthing Arrangement	Text, diagram	S, D
	Saturation curve	Diagram	R1

Symbol	Data Description	Units	Data Category
	***Generating unit* reactive capability (at machine terminals):**		
	Lagging *Reactive power* at P_{MAX}	MVAr export	S, D, R2
	Leading *Reactive power* at rated MW	MVAr import	S, D, R2
	Lagging Reactive Short Time	MVAr	D, R1, 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	Volts	S, D, R1
	Maximum Field *Voltage*	Volts	S, D, R1
	Minimum Field *Voltage*	Volts	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

Symbol	Data Description	Units	Data Category
	***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
	Normal Droop	%	D, R1
	Minimum Droop	%	D, R1
	Maximum *Frequency* Dead band	Hz	D, R1
	Normal *Frequency* Dead band	Hz	D, R1
	Minimum *Frequency* Dead band	Hz	D, R1
	MW Dead band	MW	D, R1
	***Generating unit* response capability:**		
	Sustained response to *frequency change*	MW/Hz	D, R2
	Non-sustained response to *frequency change*	MW/Hz	D, R2
	Load Rejection Capability	MW	S, D, R2
	Mechanical shaft model:		
	(Multiple-stage steam turbine *generating units* only)		
	Dynamic model of turbine/*generating unit* shaft system in lumped element form showing component inertias, damping and shaft stiffness.	Diagram	D
	Natural damping of shaft torsional oscillation modes.(for each mode		
	- Modal *frequency*	Hz	D

Symbol	Data Description	Units	Data Category
	- 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 e.g. for co*generation equipment*)	Seconds	D
	MW output versus turbine speed (47-52 Hz)	Diagram	D, R1, R2
	Type of turbine (heavy industrial, aero derivative etc.)	Text	S
	Number of shafts		S, D
	Gearbox Ratio		D
	Fuel type (gas, liquid)	Text	S, D
	Base *load* MW vs temperature	Diagram	D
	Peak load MW vs temperature	Diagram	D
	Rated exhaust temperature	°C	S, D
	Controlled exhaust temperature	°C	S, D, R1

Symbol	Data Description	Units	Data Category
	Turbine *frequency* tolerance capability	Diagram	D
	Turbine compressor surge map	Diagram	D
	Hydraulic turbine data		
	Required data will be advised by the *Network Service Provider*		
	Wind farm/wind turbine data[1]		
	A typical 24 hour power curve measured at 15 minute intervals or better if available;		S, D, R1
	maximum kVA output over a 60 second interval		S, D, R1
	Long-term flicker factor for *generating unit*		S, D, R1
	Long term flicker factor for *wind farm*		S, D, R1
	Maximum output over a 60 second interval	kVA	S, D, R1
	Harmonics current spectra	A	S, D, R1
	Power curve MW vs. wind speed	Diagram	D
	Spatial Arrangement of *wind farm*	Diagram	D
	Startup profile MW, MVAr vs time for individual Wind Turbine Unit and *Wind farm* Total	Diagram	D
	Low Wind Shutdown profile MW, MVAr vs time for individual Wind Turbine Unit and *Wind farm* Total	Diagram	D
	MW, MVAr vs time profiles for individual Wind Turbine Unit under normal ramp up and ramp down conditions.	Diagram	D
	High Wind Shutdown profile MW, MVAr vs time for individual Wind Turbine Unit and *Wind farm* Total	Diagram	D
	Induction *generating unit* data		
	Make		

Symbol	Data Description	Units	Data Category
	Model		
	Type (squirrel cage, wound rotor, doubly fed)		
MBASE	Rated MVA	MVA	S, D, R1
PSO	Rated MW (Sent out)	MW	S, D, R1
PMAX	Rated MW (*generated*)	MW	D
VT	Nominal Terminal *Voltage*	kV	S, D, R1
	Synchronous Speed	rpm	S, D, R1
	Rated Speed	rpm	S, D, R1
	Maximum Speed	rpm	S, D, R1
	Rated *Frequency*	Hz	S, D, R1
Qmax	Reactive consumption at PMAX	MVAr import	S, D, R1
	Curves showing torque, *power factor*, efficiency, stator current, MW output versus slip (+ and -).	Graphical data	D, R1, R2
	Number of *capacitor banks* and MVAr size at rated *voltage* for each *capacitor bank* (if used).	Text	S
	Control philosophy used for VAr /*voltage* control.	Text	S
H	Combined inertia constant for all rotating masses *connected* to the *generating unit* shaft (for example, *generating unit*, turbine, gearbox, etc.) calculated at the synchronous speed	MW-sec/MVA	S, D, R1
	Resistance		
Rs	Stator resistance	% on M_{BASE}	D, R1
Rs	Stator resistance versus slip curve, or two extreme values for zero (nominal) and unity (negative) slip	Graphical data or % on M_{BASE}	D, R1
	Reactance (saturated)		
X'	Transient reactance	% on M_{BASE}	D, R1

Symbol	Data Description	Units	Data Category
X''	Subtransient reactance	% on M_{BASE}	D, R1
	Reactance (unsaturated)		
X	Sum of magnetising and primary winding leakage reactance	% on M_{BASE}	D, R1
X'	Transient reactance	% on M_{BASE}	D, R1
X''	Subtransient reactance	% on M_{BASE}	D, R1
Xl	Primary winding leakage reactance	% on M_{BASE}	D, R1
	Time constants (unsaturated)		
T'	Transient	sec	S, D, R1, R2
T''	Subtransient	sec	S, D, R1, R2
Ta	Armature	sec	S, D, R1, R2
To'	Open circuit transient	sec	S, D, R1, R2
To''	Open circuit subtransient	sec	S, D, R1, R2
	Converter data		
	Control: *transmission system* commutated or self-commutated		
	Additional data may be required by the *Network Service Provider*		
	Doubly fed induction *generating unit* data		
	Required data will be advised by the *Network Service Provider*		
	Inverter connected generating systems[2]		
	Generating System Identifier[3]	text	S
	Make	text	D

Symbol	Data Description	Units	Data Category
	Model	text	D
	Maximum *apparent power* output over a 60 s interval[4]	MVA	S, D, R1
	Maximum fault current contribution[4]	kA rms symmetrical	S, D, R1
	Control modes (*voltage*, *reactive power, power factor*)[4]	Text	S, D, R1
	Attachments		
	Control system block diagram including limiters and parameters for *voltage*, *reactive power, power factor* controls	Graphical Data	S, D, R1
	Block diagram including limiters and parameters for power oscillation damper	Graphical Data	S, D, R1
	Reactive capability curve	Graphical Data	S, D, R1
	Data on power quality characteristics including flicker and harmonics similar to that specified in IEC 61400-21.		
	Long-term flicker factor for *Generator*		S, D, R2
	Long term flicker factor for *wind farm*		S, D, R2
	Harmonics current spectra		S, D, R2
	The *Network Service Provider* may specify additional data for *inverter energy systems*		

Notes:

1: Where applicable and unless requested otherwise, the data shall be provided at the site specific maximum ambient temperature.

2: A separate data sheet is required for each *generating unit* within the *generating system*.

3: Where there is more than one *generating unit*, the identifier should be the same as used on the single line diagram.

4: Aggregate capability for the entire generating system

ATTACHMENT 5 SUBMISSION REQUIREMENTS FOR ELECTRICAL PLANT PROTECTION

***Protection* data submission timeliness:**

D Within 3 *months* of signing of the *connection agreement*, or as agreed otherwise in the *connection agreement*.

R1 At least 3 *months* prior to commencement of *protection equipment* commissioning, or as agreed otherwise in the *connection agreement*.

R2 Within 3 weeks of the completion of *protection equipment* commissioning, or as agreed otherwise in the *connection agreement*.

Data Description	Data Category
***Protection* Design Philosophy:**	
Documentation explaining the general *protection* philosophy, including:	D, R1 and R2
- Present and design minimum and maximum fault levels.	
- Present and design minimum and maximum fault contributions to the *network* from the *User*, at the *connection point*.	
- Details of required *critical fault clearance times*, and which *protections* will be employed to meet these times.	
- Local Backup (*circuit breaker fail*) philosophy.	
- Special scheme philosophy (for example, islanding or *load shedding* schemes).	
- *Protection* number 1 philosophy	
- *Protection* number 2 philosophy	
Power single line diagram, down to and including the *low voltage* (greater than 50 V AC) bus(s), including:	D, R1 and R2
- *Voltage* levels,	
- *Transformer* ratings, winding configurations and earthing connections	
- *Generator* ratings and earthing connections	
- Operating status of switching devices	
- Earthing configuration	

Data Description	Data Category
- Primary plant interlocks	
Details of *protection* interfaces between the *network* and the *User*	D, R1 and R2
Protection single line diagram, down to and including the *low voltage* (greater than 50 V AC) bus(s), including:	R1 and R2
- *Current transformer* locations, rated primary and secondary current, rated short-time thermal current, rated output, accuracy class and designation.	
- *Voltage Transformer* locations, winding connections, rated primary and secondary *voltages*, rated output and accuracy class.	
- Relay make and model number	
- Relay functions employed	
- Primary plant mechanical *protections*	
- Trip details (diagrammatic or by trip matrix)	
Impedance diagram of the system, showing, for each item of primary plant, details of the positive, negative and zero sequence series and shunt impedances, including mutual coupling between physically adjacent elements. Impedances to be in per unit, referred to a 100 MVA base. Final submission (R2) to include tested values of *generator* and *transformer* impedances (for example, from manufacturer's test certificates)	R1 and R2
Tripping and control power *supply* (e.g. DC system) single line diagram.	R1 and R2
Power flow details at point of connection as per the data requested in Attachment 5.	R1 and R2
HV circuit breaker details, including:	R1 and R2
- A control and *protection* schematic diagram of the circuit breaker(s) at the *User* connection to the *network*	
- Type, rated current and rated fault MVA or rated breaking current of all HV circuit breakers	
HV switch fuse details, including:	R1 and R2
- Rated current of fuse	
- Rated breaking current of fuse	

Data Description	**Data Category**
- Type of fuse	
- Current-time characteristic curves	
***Protection* Settings Design Philosophy:**	
Documentation explaining the general *protection* settings philosophy	R1 and R2
Calculated *critical fault clearance times*	R1 and R2
Protection function settings to be employed and reasons for selecting these settings. Diagrams to be submitted where applicable.	R1 and R2
Overcurrent grading curves for phase faults.	R1 and R2
Overcurrent grading curves for earth faults	R1 and R2

ATTACHMENT 6 GENERATING UNIT (>10 MW) SETTING DATA

Data Description	Units	Data Category
***Protection* Data:**		
Settings of the following *protection*s:		
Loss of field	Text	D
Under excitation	Text, diagram	D
Over excitation	Text, diagram	D
Differential	Text	D
Under *frequency*	Text	D
Over *frequency*	Text	D
Negative sequence component	Text	D
Stator 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 should be provided in accordance with clause 2.3.7.1 and clause 3.3.9 and as specified in the Network Modelling Procedure.	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 should be provided in accordance with clause 2.3.7.1 and clause 3.3.9 and as specified in the Network Modelling Procedure.	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

Data Description	Units	Data Category
V/f limiter (if fitted)	Text, diagram	D

ATTACHMENT 7 TRANSMISSION SYSTEM AND EQUIPMENT TECHNICAL DATA OF EQUIPMENT AT OR NEAR CONNECTION POINT

Data Description	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

Data Description	Units	Data Category
***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.		
Short Circuit Infeed to the *Transmission system*	% on 100 MVA base	S, D, R1
Maximum *Generating unit* 3-phase short circuit infeed including in-feeds from *generating units connected* to the *User's* system, calculated by method of *AS* 3851 (1991)(Amndt 1-1992).	kA symmetrical	S, D, R1
The total infeed at the instant of fault (including contribution of induction motors).	kA	D, R1
Minimum zero sequence impedance of *User's transmission system* at *connection point*.	% on 100 MVA base	D, R1
Minimum negative sequence impedance % on 100 MVA base of *User's transmission system* at *connection point*.	% on 100 MVA base	D, R1
***Load* Transfer Capability:**		
Where a *load*, or group of *loads*, may be fed from alternative *connection points*:		
Load normally taken from *connection point* X	MW	D, R1
Load normally taken from *connection point* Y	MW	D, R1
Arrangements for transfer under planned or fault *outage* conditions.	Text	D
Circuits Connecting *Embedded generating units* to the *Transmission system*:		
For all *generating units*, all connecting lines/cables, *transformers* etc.		
Series Resistance (+ve, -ve & zero seq.)	% on 100 MVA base	D, R
Series Reactance (+ve, -ve & zero seq.)	% on 100 MVA base	D, R
Shunt Susceptance (+ve, -ve & zero seq.)	% on 100 MVA base	D, R
Normal and short-time emergency ratings	MVA	D, R
Technical Details of *generating units* as per schedules S1, S2		

Data Description	Units	Data Category
***Transformers* at *connection points*:**		
Saturation curve	Diagram	R

ATTACHMENT 8 TRANSMISSION SYSTEM EQUIPMENT AND APPARATUS SETTING DATA

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 changers.	Seconds	D, R1
Reactive Compensation (including filter banks):		
Location and Rating of individual *shunt reactors*	MVAr	D, R1
Location and Rating of individual shunt MVAr *capacitor bank*s	MVAr	D, R1
Capacitor bank capacitance	microfarads	D
Inductance of switching *reactor* (if fitted)	milli-Henries	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		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

Data Description	Units	Data Category
Islanding scheme:		
Triggering signal (e.g. *voltage*, *frequency*)	Text	S, D
Relay settings	Control settings	S, D

ATTACHMENT 9 LOAD CHARACTERISTICS AT CONNECTIONS POINT

Data Description	Units	Data Category
For all Types of *Load*		
Type of *Load* e.g. controlled rectifiers or large motor drives	Text	S
Rated capacity	MW, MVA	S
Voltage level	kV	S
Rated current	A	S
For Fluctuating *Loads*		
Cyclic variation of *active power* over period	Graph MW/time	S
Cyclic variation of *reactive power* over period	Graph MVAr/time	S
Maximum rate of *change* of *active power*	MW/s	S
Maximum rate of *change* of *reactive power*	MVAr/s	S
Shortest Repetitive time interval between fluctuations in *active power* and *reactive power* reviewed annually	s	S
Largest step *change* in *active power*	MW	S
Largest step *change* in *reactive power*	MVAr	S
For commutating power electronic *load*:		
No. of pulses	Text	S
Maximum *voltage* notch	%	S
Harmonic current distortion (up to the 50th harmonic)	A or %	S

ATTACHMENT 10 DISTRIBUTION SYSTEM CONNECTED GENERATORS UP TO 10 MW (EXCEPT INVERTER-CONNECTED GENERATORS UP TO 1000 KVA)

Data Description	Data Category
Power Station	
Address	S, R1
Description of *power station*, for example, is it a green or brownfield site, is there a process steam or heat requirement, any other relevant information.	S
Site-specific issues which may affect access to site or design, e.g. other construction onsite, mine site, environmental issues, soil conditions.	S, D
Number of *generating units* and ratings (kW)	S, D, R1
Type: e.g. synchronous, induction	S, D, R1
Manufacturer:	D
Connected to the *network* via: e.g. inverter, *transformer*, u/g cable etc.	S
Prime mover types: e.g. reciprocating, turbine, hydraulic, photovoltaic, other	S
Manufacturer	D
Energy source: e.g. natural gas, landfill gas, distillate, wind, solar, other	S
Total *power station* total capacity (kW)	S, D, R1
Power station export capacity (kVA)	S, D, R1
Forecast annual *energy* generation (kWh)	S, D
Normal mode of operation as per clause 3.4.2(d) of Technical *Rules* i.e. (1) continuous parallel operation (2) occasional parallel operation (3) short term test parallel operation (4) bumpless transfer, [(A) rapid (B) gradual]	S
Purpose: e.g. power sales, peak lopping, demand management, exercising, emergency back up	S

Data Description	**Data Category**

Associated Facility Load

Expected *peak load* at *facility* (kW)	S, D, R1
Forecast annual *energy* consumption (kWh)	S
Construction *supply* required?	S
Max construction power	S
Required connection date	S
Required full operation date	S
Expected life	S

Additional Information Required

1)	Proposed arrangement & site layout of the *power station* including prime movers, *generators*, *transformers*, synchronising circuit breakers and lockable *disconnect* device. Each component should be identified so that the plan can be cross-referenced to the data provided.	S, D
2)	Single line diagram & earthing configuration.	S, D, R2
3)	Details of *generator* maximum kva output over 60 second interval.	S, D, R2
4)	A typical 24 hour *load* power curve measured at 15 minute intervals or less.	S, D. R2
5)	Calculation of expected maximum symmetrical 3 phase fault current contribution	S, D,
6)	Data on power quality characteristics for wind *generators* (including flicker and harmonics) to IEC 61400-21	S, D, R2
7)	Where requested by the *Network Service Provider in accordance with clauses 2.3.7.1 and 3.3.9*, aggregate data required for performing stability studies shall be provided along with results of preliminary studies (if available) as detailed in the Network Modelling Procedure.	D

Data Description	Unit	Data Category
Transformers[1]		
Identifier[2]		
Number of windings	Number	S
Rated MVA of each winding	MVA	S, D
Principal tap rated *voltages*	kV/kV	S
Positive sequence impedances (each wdg)[3]	(a+jb)%	D, R1
Negative sequence impedances (each wdg)[3]	(a+jb)%	D, R1
Zero sequence impedances (each wdg)[3]	(a+jb)%	D,R1
Tapped winding	Text or diagram	S
Tap change range	kV-kV	D
Tap change step size	%	D
Number of taps	Number	D
Tap changer type, on/off *load*	On/Off	S
Tap change cycle time	S	D
Vector group	Text or diagram	S

Attachments required

Earthing arrangement		S, D

NOTES:

1) A separate data sheet is required for each *transformer*.
2) Where there is more than one *transformer*, the identifier should be the same as used on the single line diagram.
3) Base quantities must be clearly stated.

Data Description	Unit	Data Category
Synchronous Generators[1]		
Identifier[2]		
Make	Text	D
Model	Text	D
Rated kVA	kVA	S, D, R1
Nominal terminal *voltage*	kV	D
Number of pole-pairs	No	
Speed	rpm	
Rated kW (sent out)	kW (sent out)	S, D, R1
Minimum *load* (ML)	kW (sent out)	D, R1
Inertia constant (H) for *generator* only	kW-sec/rated kVA	D, R1
Inertia constant (H) for all rotating masses *connected* to the *generator* shaft (for example, *generator*, turbine, etc.). Include gearbox (if any)	kW-sec/rated kVA	D, R1
Short circuit ratio		D, R1
Neutral earthing impedance[3]	(a+jb)%	D, R1
Sequence Impedances (saturated)		
Zero sequence impedance[3]	(a+jb)%	D, R1
Negative sequence impedance[3]	(a+jb)%	D, R1
Reactance (saturated)		
Direct axis transient reactance[3]	%	D, R1
Direct axis sub-transient reactance[3]	%	D, R1
Reactive capability (at machine terminals)		
Maximum lagging (overexcited) *reactive power* at rated kW	kVAr export	S, D, R2

Data Description	Unit	Data Category
Maximum leading (underexcited) *reactive power* at rated kW	kVAr import	S, D, R2
Lagging reactive short time capability at rated kW, terminal *voltage* and speed	kVAr for time	D, R1

Synchronous Generators (continued)

Attachments

Capability chart (Indicate effect of temperature and *voltage*)	Graphical data	S, D, R1

NOTES:

1) A separate data sheet is required for each *generator*.
2) Where there is more than one *generator*, the identifier should be the same as used on the single line diagram.
3) Base quantities must be clearly stated

Induction Generators[1]

Data Description	Unit	Data Category
Identifier[2]		
Make	Text	D
Model	Text	D
Rated kVA	kVA	S, D, R1
Rated kW (sent out)	kW (sent out)	S, D,R1
Reactive consumption at rated kW	kVAr	S, D, R1
Nominal terminal *voltage*	kV	D
Synchronous speed	rpm	D
Rated speed	rpm	D, R1
Maximum speed	rpm	D, R1
Rated *frequency*	Hz	D
Single or (effectively) double cage machine	Text	D, R1

Data Description	Unit	Data Category
Generator reactance (saturated)		
Transient reactance[2]	%	D, R1
Subtransient reactance[2]	%	D, R1
Control: *network* commutated or self-commutated	Text	S, R1
Attachments		
Curves showing torque, *power factor*, efficiency, stator current, kW output versus slip (+ and -).	Graphical Data	S, D, R1

NOTES:

1) A separate data sheet is required for each *generator*.
2) Base quantities must be clearly stated.
3) Where there is more than one *generator*, the identifier should be the same as used on the single line diagram.

Inverter-Connected Generators[1]

Data Description	Unit	Data Category
Identifier[2]		
Make	text	D
Model	text	D
Maximum kVA output over a 60 s interval	kVA	S, D, R1
Maximum fault current contribution	kA rms symmetrical	S, D, R1
Control modes (*voltage*, *power factor*)	text	S, D, R1
Attachments		
Reactive capability curve	Graphical Data	S, D, R1
Long-term flicker factor for *generator*[3]		S, D, R2
Long term flicker factor for *wind farm*[3]		S, D, R2
Harmonics current spectra[3]		S, D, R2

NOTES:

1) A separate data sheet is required for each *generator*.
2) Where there is more than one *generator*, the identifier should be the same as used on the single line diagram.

3) In accordance with IEC 61400-21.

Wind Turbine/Wind Farm

Data Description	Unit	Data Category
Flicker factors in accordance with IEC 61400-21	Text / Diagram	S, D, R2
Annual average wind speed	metre/sec	S
Harmonics current spectra	Text / Diagram	S, D, R2

Attachments

A typical 24 hour power curve measured at 15-minute intervals or better if available		S, D,R2
Startup profile kW, kVAr vs time for individual wind turbine		S, D, R2
Startup profile kW, kVAr vs time for *wind farm* total		S, D, R2
kW, kVAr vs time profiles for individual wind turbine under normal ramp up and ramp down conditions		S, D, R2
High wind shutdown profile kW, kVAr vs time for individual wind turbine		S, D, R2
High wind shutdown profile kW, kVAr vs time for *wind farm* total		S, D, R2
Low wind shutdown profile kW, kVAr vs time for individual wind turbine		S, D, R2
Low wind shutdown profile kW, kVAr vs time for *wind farm* total		S, D, R2
Power curve kW vs wind speed		S, D, R2
Spatial arrangement of *wind farm*		S, D, R1

ATTACHMENT 11 TEST SCHEDULE FOR SPECIFIC PERFORMANCE VERIFICATION AND MODEL VALIDATION

A11.1 General

(a) These tests apply to all generator types (unless otherwise indicated) including but not limited to:

- Synchronous Generators – Gas Turbines
- Synchronous Generators – Reciprocating Engines
- Synchronous Generators – Hydro
- Induction Machines
- Inverter Connected Generators – Wind
- Inverter Connected Generators – Solar
- Battery Energy Storage Systems

The term 'Generating Unit' is used to represent each of these devices in this section.

(b) Recorders must be calibrated/checked prior to use.

(c) Recorders must not interact with any *equipment* control functions.

(d) One chart recorder must be used to provide onsite monitoring and rapid evaluation of key quantities during tests even though a digital recorder may be used.

A11.2 Recorder *Equipment*

Signals shall be digitally recorded and processed and require:

(a) an analogue to digital conversion with at least 12 bit accuracy at full scale;

(b) a sampling rate of at least 3000 samples per second (i.e. 3 kHz) for up to 10 seconds unless specified otherwise;

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

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

A11.3 *Frequency* response

(a) A minimum bandwidth of DC – 10 kHz is required (0 dB at DC, -3 dB at 10 kHz). 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 – 100 Hz is required.

(c) All test results required in rms values are to be derived at a minimum rate of 100 samples per second.

A11.4 Signal Requirements and Conditioning

(a) Suitable input signal level must be used and allowance must be made for excursions during transients.

(b) Subtraction of an appropriate amount of floating DC from input signals such as stator *voltage* must be provided so that any perturbations are clearly observable on an on-site chart recorder.

(c) Galvanic isolation and filtering of input signals must be provided whenever necessary.

A11.5 Form of Test Results

These must consist of:

(a) a brief log showing when tests were done (time, date, test alphanumeric identification);

(b) chart recordings appropriately annotated;

(c) relevant schematics of *equipment* and the local *transmission system* configuration;

(d) lists of data collected manually (e.g. meter readings);

(e) data on Microsoft Excel spreadsheets;

(f) SCADA type printouts showing the *User's power system* configuration at the start of, end of, and any other appropriate time during the test sequence; and

(g) other relevant data logger printouts (from other than the recorder *equipment* referred to in clause A11.2).

A11.6 Test Preparation and Presentation of Test Results

Information/Data Prior to Tests

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

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

(c) Most up to date relevant technical data and parameter settings of *equipment* as specified in Attachment 4 to Attachment 10.

Test Notification

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

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

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

Test Results

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

(b) Where test results show that *generator* performance does not comply with the requirements of these *Rules* or the *access contract* or *connection agreement* it will be necessary to rectify problem(s) and repeat tests.

A11.7 Quantities to be Measured

(a) Wherever appropriate and applicable for the tests, the following quantities must be measured on the machine under test using either the same recorders or, where different recorders are used, time scales must be synchronised to within 1 ms:

***Generating unit* and Excitation System**

- L-N terminal *voltages*
- Terminal currents
- Active power MW
- Reactive power MVAr
- Generating unit rotor field voltage
- *Generating unit* rotor field current
- Main exciter field *voltage*
- Main exciter field current
- AVR reference *voltage*
- *Voltage* applied to voltage controller summing junction (step etc.)
- *Power system* stabiliser output
- DC signal input to voltage controller

Synchronous Machines

- Shaft speed
- *Load* demand signal
- Valve positions for control and interceptor valves
- Turbine control set point

Gas Turbine

- Shaft speed (engine)
- Shaft speed of turbine driving the *generating unit*
- Engine speed control output
- Free turbine speed control output
- *Generating unit*-compressor speed control output
- Ambient/turbine air inlet temperature
- Exhaust gas temperature control output
- Exhaust temperature
- Fuel flow
- Turbine control / *load* reference set point

Hydro

- Shaft speed
- Gate position
- Turbine control /*load* reference set point

(b) The *Network Service Provider* must specify test quantities for power *equipment* other than those listed above, such as those consisting of wind, solar and fuel cell *generating units* which may also involve AC/DC/AC power conversion or DC/AC power inverters.

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

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

SCHEDULE OF TESTS

Table A11.1 - Schedule of compulsory tests

Test No.	Test Description	Changes Applied	Test Conditions	Pass Criteria
C1	Step change to voltage reference with the generating unit on open circuit	(a) +2.5% (b) -2.5% (c) +5.0% (d) -5.0%	▪ Nominal terminal volts ▪ Generator CB Open	▪ Achievement of required voltage controller response time ▪ Correct functioning of voltage controller for step changes ▪ Compliance with technical rules Table 3.1 (+/-10% of the increment within 2.5 seconds) ▪ Compliance with contractual agreements
C2	Step change to voltage reference with the generating unit connected to the system or appropriately sized load bank.	(a) +2.5% (b) -2.5% (c) +5.0% (d) -5.0%	▪ Repeat for generating unit output levels: (i) 50% rated real power, and (ii) 100% rated real power ▪ 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 ▪ Repeat with PSS in/out of service	▪ Achievement of required voltage controller response time ▪ Correct functioning of voltage controller for step changes ▪ Compliance with technical rules Table 3.1 (+/-10% of the increment within 2.5 seconds) ▪ Compliance with contractual agreements
C3	Step change to voltage reference with the generating unit connected to the system.	(a) +5 % (b) –5%	▪ Repeat for 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	▪ Achievement of required voltage controller response time ▪ Correct functioning of voltage controller for step changes ▪ Compliance with technical rules Table 3.1 (+-10% of the increment within 2.5 seconds) ▪ Compliance with contractual agreements

Test No.	Test Description	Changes Applied	Test Conditions	Pass Criteria
			▪ Nominal stator terminal volts ▪ Unity or lagging power factor ▪ Generating unit output at 100% rated real power ▪ Repeat with PSS in/out of service	
C4	Step Load (real power)	(a) +30% (b) +50% (BESS) where the step load as a % of rated real power output; and (c) any step load tests as specified in the relevant technical specification or contract. May be achieved by switching a: (a) load bank; (b) generator; (c) transmission or distribution circuits (nominated by the *Network Service Provider*); or (d) sending a real power setpoint to the generator with ramping functions disabled (large generators >10MW only).	▪ Repeat for generating unit starting outputs at: (i) generator specified minimum load capability, (ii) 50% rated real power, and (iii) For BESS, should be charging (-50% rated real power) at the point in time the step is applied ▪ Nominal stator terminal volts ▪ Rated leading power factor or as advised by the *Network Service Provider* ▪ The test may need to be repeated on the power system with multiple units in service as advised by the *Network Service Provider* (refer Special Test S3).	▪ Returns to voltage and frequency standard in Horizon Power Technical Rules Section 2, and relevant contract or technical specification. ▪ Adequate disturbance ride through (rides through step)
C5	Load rejection (real power)	(a) -30% (b) -50% (c) -100% May be achieved by switching a: (a) load bank; (b) generator; (c) transmission or distribution circuits (nominated by the *Network Service Provider*); or (d) sending a real power setpoint to the generator with ramping functions disabled (large generators >10MW only).	▪ Nominal stator terminal volts ▪ Unity power factor or as advised by the *Network Service Provider* ▪ Smaller amount must precede larger amount of load rejection ▪ The test may need to be repeated on the power system with multiple units in service as advised by the *Network Service Provider* (refer Special Test S3).	▪ Returns to voltage and frequency standard in Chapter 2 of these *Rules*, and relevant contract or technical specification. ▪ Adequate disturbance ride through (rides through step) ▪ Reverse power control schemes on synchronous machines operates correctly

Test No.	Test Description	Changes Applied	Test Conditions	Pass Criteria
C6	Steady state over-excitation limiter (OEL) operation (synchronous generators with OEL only)	MVAr outputs at OEL setting slow raising of excitation to just bring OEL into operation (see notes below)	▪ 100% real power output ▪ 75% real power output ▪ 50% real power output ▪ 25% real power output ▪ minimum real power output	▪ Correct operation of over-excitation limiters ▪ Controller limits and signals remain stable ▪ Output within reactive power capability curve
C7	Steady state under-excitation limiter (UEL) operation (synchronous generators with UEL only)	MVAr outputs at UEL setting slow lowering of excitation to just bring UEL into operation (see notes below)	▪ 100% real power output ▪ 75% real power output ▪ 50% real power output ▪ 25% real power output ▪ minimum real power output	▪ Correct operation of under-excitation limiters ▪ Controller limits and signals remain stable ▪ Output within reactive power capability curve
C8	Manual variation of generating unit open circuit voltage	Open circuit terminal volt (Ut): (a) increase from 0.5 pu to 1.1 pu (b) decrease from 1.1 pu to 0.5 pu	▪ Generator CB Open ▪ 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	▪ Generator Voltage Output Follows Setpoint ▪ Information in accordance with manufacturer specification, information provided for model validation
C9	Reactive Power capability - MVAr capability	Generating unit real and reactive power output levels varied throughout full reactive capability range. Maximum and minimum reactive power set to 100% of rated values and maintained for one hour.	▪ No output to full output. ▪ Test conducted at system maximum load and maximum generation or with generating units at maximum output connected to the power system or an appropriately sized load bank. ▪ Test conducted with as high an ambient temperature as possible. ▪ System maximum load and generation or maximum generation connected to load bank ▪ Ambient temperature as high as possible	▪ Full range of reactive capability curve demonstrated, consistent with technical specifications. ▪ Rating and correct operation of reactive power compensation equipment. ▪ Balanced with other generators in parallel ▪ Output sustained for reasonable period (generators run for 1 hour) without faulting
C10	Frequency Droop (Hz-Watt) Response	Vary frequency and measure generator output at each point on the droop curve.	▪ For starting load levels initially set at: (i) 50% (ii) 0% (iii) -50% (BESS units only)	Follows correct droop characteristic in accordance with section 3.3.4.4 of these *Rules* and relevant agreements and technical specifications.

Test No.	Test Description	Changes Applied	Test Conditions	Pass Criteria
C11	P Set-point Control	▪ Dispatch generator P = 0%, +/-25%, +/-50%, +/-100% of rated real power output (-ve dispatch for batteries only). ▪ Sustained output for three hours at maximum rated real power output.	▪ Normal load conditions; ▪ Normal power factor; ▪ Ensure generator does not go below minimum/above maximum loading conditions.	▪ Test the P Active Capability of the generator ▪ P setpoint reached ▪ The generating unit is capable of specified sustained output of real power (reliability run of 3 hours per unit) ▪ Test ramp up and ramp down time - ramp rates comply
C12	Q Set-point Control	▪ Dispatch generator Q = 0%, +/-25%, +/-50%, +/-100% of rated reactive power output. ▪ Sustained output for three hours at maximum rated reactive power output.	▪ Normal load conditions	▪ Reactive power setpoint reached ▪ Test response and Ramp Up/Down Time to setpoint control
C13	State of Charge (SOC) Management (Battery Energy Storage Systems only)	▪ BESS state of charge varied across full range of available SOC ▪ Adjust SOC setpoint values to confirm charge / discharge functions work appropriately (all SOC levels as detailed in relevant control philosophy) ▪ Full charge discharge cycle to validate total capacity of BESS against technical specifications		▪ State of Charge Set-point Limits validated ▪ Full range of SOC demonstrated ▪ SOC management functions in accordance with control philosophy ▪ Charge and discharge rates able to be altered and verified. ▪ Ability to change the Battery SOC Control Curves by altering relevant parameters ▪ Confirm power limits and smooth variation of charge/discharge rates at each SOC threshold setpoint ▪ Verify BESS starts, status changes (i.e. healthy, online etc) ▪ Primary response remains active across the required SOC range

Test No.	Test Description	Changes Applied	Test Conditions	Pass Criteria
				▪ Total capacity of BESS validated in accordance with relevant agreements and technical specifications.
C14	Default/Failsafe Mode (loss of communications)	Communications to device interrupted for the following communications channels: ▪ SCADA & tertiary controllers ▪ Microgrid/Plant controller ▪ RTUs ▪ Other critical local devices or networks	▪ Normal generator output	▪ Device goes to safe operating level in accordance with specifications. ▪ Relevant alarms sent and failsafe mechanisms are enacted. ▪ System reverts to normal operation once communications restored.

NOTES:

1. All compulsory tests to be performed.
2. Special tests may be required as detailed in table A11.2. Special tests to be advised by the *Network Service Provider*.
3. Factory or site-based tests will be accepted for tests C1, C2, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13 and C14. All other tests (C3) must be site-based tests.
4. ‘Generator’ or ‘Generating Unit’ means the generator under test and may include (but not be limited to) synchronous machines, induction machines, inverter connected generators, wind, solar, battery energy storage systems, and fuel cells.
5. Battery Energy Storage systems (BESS) and inverter connected generators (eg Wind, Solar) must undertake all tests required for generators unless otherwise advised by the *Network Service Provider*.
6. Tests to be performed for each unit making up the proposed power facilities.
7. Tests to be done for suitable dispatch configurations and credible outage configurations as advised by the *Network Service Provider*.
8. Tests to be performed in all relevant operating modes and system states for the generator (eg Grid Connected vs Islanded, HON, HOF, and any alternative voltage or frequency control modes) as advised by the *Network Service Provider*.
9. Where a Power System Stabiliser is installed, relevant power system connected tests (C2, C3, C4, S4) to be performed with and without the PSS in service as directed by Horizon Power
10. Where new units are added to existing sites, tests are only required to be completed for those units, and multiple unit configurations involving those units, unless otherwise advised by the *Network Service Provider*.
11. Tests at low power output levels must precede tests at higher power output levels

12. Tests with smaller step changes must precede larger step changes. Care must be taken not to excite large or prolonged oscillations in MW etc.
13. The Figure A 11.1 below shows the step changes referred to in the schedule of tests given 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.

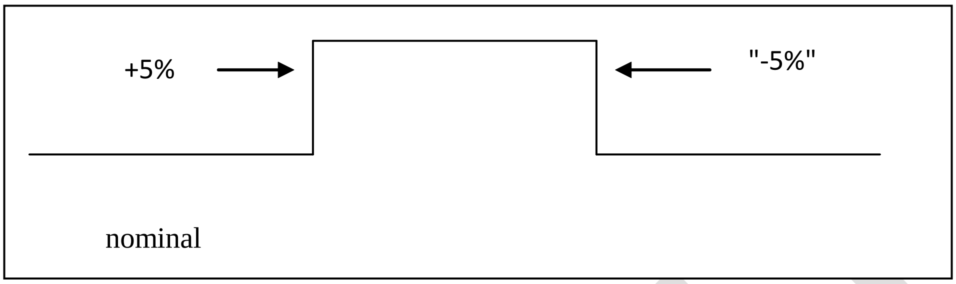

Figure A11.1 - Application of step signal

14. Unless specified otherwise the "-5%" step method shown in Figure A11.1 is used.
15. With the agreement of the *Network Service Provider* the output of the generator being tested via step tests while connected to the system or load bank may be restricted levels lower than 100% of rated real power output, where such a restriction is required by the capacity of the available load bank or other generating units to respond to the step change.
16. For test C5, the instantaneous overspeed protection must be set at an agreed level depending on unit capability
17. 16 Any other tests to demonstrate compliance with a declared or registered equipment performance characteristic may be specified by the *Network Service Provider*.

SPECIAL SYSTEM TESTS THAT MAY BE REQUESTED

Table A11.2 – Schedule of special system tests

Test No.	Test Description	Changes Applied	Test Conditions	Pass Criteria
S1A	Reactive Power Step Load	+30 % rated MVAR Can be achieved by switching in and out of: (a) a reactive load bank (b) a transformer (c) a reactor (d) a capacitor	▪ Nominal stator terminal volts ▪ 0 or minimum real power output. ▪ Repeat with Excitation on Auto and Manual control	▪ Returns to voltage and frequency standard in Chapter 2 of these *Rules*, and relevant contract and technical specifications ▪ Adequate protection settings window (rides through)
S1B	Reactive Power Load rejection	-30 % rated MVAR Can be achieved by switching in and out of: (a) a reactive load bank (b) a transformer (c) a reactor (d) a capacitor	▪ Nominal stator terminal volts ▪ 0 or minimum real power output. ▪ Repeat with Excitation on Auto and Manual control	Returns to voltage and frequency standard in Horizon Power Technical Rules Section 2, and relevant contract and technical specifications adequate protection settings window (rides through)
S2	Reactive Power Sharing	Subject the generator to a reasonable range of reactive power variations, including a credible reactive power step change to the system and monitor to ensure reactive power sharing control schemes function correctly.	Normal load conditions	▪ Correct sharing of reactive power between generators under normal conditions in accordance with relevant agreement or technical specification. ▪ Reactive Power within Technical Rules requirements (Section 3.3.3.1 of these *Rules*) ▪ Generator reactive power limits respected ▪ Reactive reserve (N-1) sufficient ▪ Within power factor of these *Rules* ▪ Within reactive power capability and any power factor/reactive power requirements of the relevant agreement or

Test No.	Test Description	Changes Applied	Test Conditions	Pass Criteria
				technical specification
S3	Step load (real and reactive power) on the power system	Step load on the power system of: (a) +30% of system normal load; (b) -30% of system normal load; or (c) largest credible step load as advised by the *Network Service Provider* This can be achieved by switching in and out of: (a) a load bank (b) a generator (c) a transformer (d) a reactor (e) a capacitor	▪ Conducted with normal generators in service ▪ May be connected to the full power system or a representative subset of loads and generators (eg split bus) as advised by *Network Service Provider* ▪ Others as determined by *Network Service Provider* ▪ Repeat for islanded or Hydrocarbons OFF configurations as advised by *Network Service Provider*	▪ Provides required active and reactive power contributions to the step load ▪ Returns to voltage and frequency standard in Chapter 2 of these *Rules*, and relevant contract and technical specifications ▪ Adequate disturbance ride through (rides through step)
S4A	Unplanned Islanding or Hydrocarbons Off (HOF) Transitions	▪ Unplanned 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 to establish the island OR trip last conventional generator on the system to transition to Hydrocarbons Off HOF); ▪ Mode Transition (T1) Unplanned Island (or HON to HOF); ▪ Mode Transition (T3) Reconnect (or HOF to HON)	Repeat for load levels/exports of: ▪ 5-10% of generated real power exported by means of the link ▪ 90-95% of generated real power used by the subsystem's load	▪ Confirm inverter based generation or island takes up load. ▪ Verify system stabilises ▪ voltage and frequency is stable (Chapter 2 of these *Rules*). ▪ Power Quality within limits. ▪ Required generators remain online and suitably share load. ▪ Automated schemes to restore normal grid configuration are either initiated (e.g. has start next diesel) OR system stays in islanded/HOF state as required.

Test No.	Test Description	Changes Applied	Test Conditions	Pass Criteria
S4B	Planned Islanding or Hydrocarbons Off (HOF) Transitions	▪ Mode Transition (T2) Planned Island (or HON to HOF) ▪ Mode Transition (T3) Reconnect (or HOF to HON)	Network in suitable state for islanding / HOF operation	▪ Transition checks completed ▪ Correct HOF transition followed (i.e. via zero transfer) ▪ Verify system stabilises - voltage and frequency is stable (Chapter 2 of these *Rules*). ▪ Power Quality within limits. ▪ Generators suitably sharing load ▪ No unexpected generator trips ▪ Reconnect transition correct
S5	AVR/OEL changeover (Synchronous Generators)	Transformer tap change OR small step to AVR voltage reference	Initially under AVR control at lagging power factor but close to OEL limit	OEL control works in accordance with relevant technical specification
S6	AVR/UEL changeover (Synchronous Generators)	Transformer tap change OR small step to AVR voltage reference	Initially under AVR control at leading power factor but close to UEL limit	UEL control works in accordance with relevant technical specification
S7	Voltage Droop (Volt-Var) Response	Vary voltage and measure generator reactive power output at each point on the droop curve. Set primary Volt –Var droop curves. Verify primary droop response.	Normal load conditions.	▪ Follows correct droop characteristic in accordance with clause 3.3.4.5 and relevant agreements and technical specifications. ▪ Deadband functions correctly (if applicable)
S8	Tripping of an adjacent generating unit	Tripping of largest credible generating unit(s)	Initial generating unit loading as determined by *Network Service Provider*	▪ System remains stable and returns to voltage and frequency standard in Horizon Power Technical Rules Section 2, and relevant contract and technical specifications ▪ Adequate protection settings window (rides through) ▪ Relevant alarms are initiated ▪ Relevant parameters (such

Test No.	Test Description	Changes Applied	Test Conditions	Pass Criteria
				as available operating reserve) are updated ▪ Remaining generators stay on line and Share kW and kVar in accordance with agreed Control Philosophy
S9	Variable frequency injection into the AVR summing junction	0.01-100 rad/sec See notes below	As determined by *Network Service Provider*	
S10	Step change to governor/load reference	(a) 2.5 % step increase in real power demand signal (b) 2.5 % decrease in real power demand signal (c) equivalent of 0.05 Hz 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 real power ▪ Others as agreed with the *Network Service Provider*	System remains stable and returns to voltage and frequency standard in Horizon Power Technical Rules Section 2, and relevant contract and technical specifications
S11	Frequency Ride Through and off nominal frequency capability	Test ride through in accordance with technical rules limits for: (a) Overfrequency (52.5 Hz/6 sec - Pilbara, or 55 Hz/5 sec - Non Interconnected Systems), and (b) Underfrequency (47.5 Hz/6 sec - Pilbara, or 45 Hz/5 sec - Non Interconnected Systems); or (c) As specified in the relevant connection agreement or technical specification.	Unsynchronised unit at rated speed and no load For Synchronous Gens: (a) Digital governor: use software, where practical, to put a step in the speed reference of the turbine governor to achieve the target speed, and measure the overshoot in speed (b) Use a manual control to vary speed from 50 Hz. Where practical, use a function generating unit to inject an analogue signal in the appropriate summing junction, to alter turbine speed.	▪ Sustained operation for power system disturbances, protection allows operation through power system disturbances as detailed in Chapter 2 and clause 3.3.3.2 of these *Rules* ▪ Generating units have been manufactured to meet the requirements of the Rules for riding through power system disturbances ▪ Adequate protection settings window to ride through

Test No.	Test Description	Changes Applied	Test Conditions	Pass Criteria
S12	Voltage Ride Through and off nominal voltage capability	Test ride through in accordance with technical rules limits for: (a) Overvoltage (+10%/1 min), and (b) Undervoltage (-100%/ 460 msec, -80%/ 10 sec); or (c) As specified in the relevant connection agreement or technical specification.		▪ Sustained operation for power system disturbances, protection allows operation through power system disturbances as detailed in clause 3.3.3.2 of these *Rules* ▪ Generating units have been manufactured to meet the requirements of the Rules for riding through power system disturbances; ▪ Adequate protection settings window to ride through
S13	Ramp rates	Renewable Smoothing Tests (disconnection of renewable source and follows ramp rate, or monitoring over extended period)		▪ Rate of change of active power for renewable assets (non-dispatchable generators) complies. ▪ Renewable smoothing ramp rates comply (LV EG systems). ▪ Technical rules rate of change of active power complies (clause 3.3.3.5 of these *Rules*)
S14	Connection (synchronisation), and disconnection - Inrush current, voltage transients and step voltage changes checked	Connect and Disconnect Unit, Record Peak Current and duration		▪ Starting inrush current is within specified limits; ▪ Voltage transients at the connection point on connection are within specified limits; ▪ Step changes in voltage on connection and disconnection (both before and after tap-changing) are within required limits. ▪ Correct functioning of automatic

Test No.	Test Description	Changes Applied	Test Conditions	Pass Criteria
				synchronising equipment prior to synchronisation. ▪ Generators synchronise and share proportional load, generators synchronise within required timeframes.
S15	Power Quality Monitoring Tests	Network flicker and harmonics levels before and after connection and confirmation that limits have not been exceeded.	Normal load conditions.	▪ Power factor during starting and normal operation is within specified limits; and ▪ Power quality parameters comply with Chapter 2 of these *Rules*.
S16	Protection Tests - Anti-islanding	Test anti-islanding functions, including but not limited to: 1. Check status of anti-islanding schemes when connected to the grid, in transition to island, islanded mode, in transition to grid connect mode. 2. Verify that the microgrid in islanded mode collapses – confirm for both active and passive anti islanding schemes.	Normal load conditions.	▪ Verify microgrid / island collapses in island mode where anti-islanding is enabled ▪ Stops in required time ▪ Over/Under Voltage/Frequency protection settings validated (passive anti islanding validated)
S17	Accumulated Synchronous Time Error	Frequency and time error monitored for 24 hour period	Normal load conditions	Complies with Section 3.8 of these *Rules*
S18	Network Frequency Shift	Operate the microgrid island at (a) + 1 Hz (b) +2 Hz (c) -1 Hz (d) -2 Hz by changing the nominal frequency	Islanded/separated from main network	▪ Frequency change achieved in accordance with subclause 3.8.4(c) of these *Rules*. ▪ Returns to voltage and frequency standard in Horizon Power Technical Rules, or relevant contract ▪ Adequate protection settings

Test No.	Test Description	Changes Applied	Test Conditions	Pass Criteria
				window (rides through)
S19	Generator Maximum Load / Overload Management	(a) Overload simulated by reduction of generator maximum limit, or application of load bank to simulate an overload on the generator and ensure control systems work accordingly (b) Overload capability of the generator unit tested by applying a load bank to ensure generator operates up to its overload capability (c) Overload capability for short circuits verified	Normal load conditions, system support plant (e.g. BESS) online	▪ Generator stays within maximum limits in accordance with relevant agreements and technical specifications. ▪ Other devices (e.g. BESS) respond to prevent generator overload and system stabilises ▪ Overload management functions (e.g. Next Unit Start, Rate of Change of Active Power) work correctly ▪ Time delay functions work and time delays appropriate ▪ Reactive power capability - inverter based devices able to go to SCR fault capability
S20	Generator Minimum Load Management	Increase Min Gen Setpoint to a simulated high level and check the control system acts to manage generators to minimum level		▪ Generators maintaining minimum generator loading setpoint in accordance with relevant agreements and technical specifications. ▪ BESS charging as required
S21	Black Start	Mode Transition (T4) Black-Start		▪ Applicable black start procedure followed correctly in accordance with clause 3.8.16 of these *Rules* and relevant connection agreement and technical specifications. ▪ Distribution Feeders Open as required ▪ Diesel Generator Starts and closes to

Test No.	Test Description	Changes Applied	Test Conditions	Pass Criteria
				Dead Bus as required ▪ Next Available Gas Generator Starts and Synchronises to Diesel Gen ▪ Diesel Gen stops
S22	Operational Reserve Management	Update OR setpoints and monitor correct functioning of dispatch controller	Normal load conditions.	▪ Correct signals (available capacity) being sent from generators/BESS to OR algorithms (e.g. SOC/Reactive dispatch dependent available reserve from BESS) ▪ Controller time delays respected ▪ Reactive dispatch aspects considered (both Q and P reactive reserve aspects considered)
S23	Active Power Sharing, Dispatch Priority	Enable generators and verify the following: ▪ Renewable assets are online and prioritised appropriately. ▪ BESS are online and charging if required. ▪ All devices are within max, min and target setpoints	▪ Run for normal load conditions (e.g. 2 x Generators on Line at 50% load and 0.8 Lagging PF) ▪ Conduct load steps/variations (i.e. +-30%) and measure load sharing and dispatch priority	▪ Correct Sharing of Active Power under normal conditions in accordance with Control Philosophy agreed with Network Service Provided (e.g. even active power sharing across online units); ▪ Dispatch merit orders followed ▪ Engine Exercising functions work correctly ▪ Generator Cycling and Preferential Run Order work correctly ▪ Renewable assets are online and prioritised appropriately. ▪ BESS are online and charging if required.

Test No.	Test Description	Changes Applied	Test Conditions	Pass Criteria
				▪ All devices are within max, min and target setpoints
S24	Dispatch via remote SCADA system	▪ Dispatch Command from SCADA system - real & reactive power, disconnect, reconnect ▪ Test OT (Citect) Set-Point Control Functions ▪ Dispatch Command from DERMS system - real & reactive power, disconnect, reconnect ▪ To be completed for all relevant SCADA systems (e.g. Citect SCADA, Power on Advantage, DERMS)	Normal load conditions.	▪ Commands successful in accordance with sections 3.3.4.2,3.4.9, 3.5, 3.6.10.1 and 3.8.13 (as applicable) of these Rules and relevant agreements and technical specifications. ▪ Ramp rates as required.
S25	Load Shedding Scheme Tests	▪ Secondary Injection Tests of UFLS protection relays. ▪ Simulated testing of PELS schemes.	Normal load conditions.	Compliance with clause 3.6.9 of these *Rules*.

Notes:

1. Special tests to be advised by the Network Service Provider.
2. Factory or site-based acceptance tests will be accepted for tests S1A, S1B, S2, S5, S6, S7, S9, S10, S11, S12, S13, S16, S18, S25. All other tests (S3, S4, S8, S14, S15, S17, S19, S20, S21, S22, S23, S24) must be site acceptance tests.
3. ‘Generator’ or ‘Generating Unit’ means the generator under test and may include (but not be limited to) synchronous machines, induction machines, inverter connected generators, wind, solar, battery energy storage systems, and fuel cells.
4. Tests to be performed for each unit making up the proposed power facilities.
5. Tests to be done for suitable dispatch configurations and credible outage configurations as advised by the Network Service Provider.
6. Tests to be performed in all relevant operating modes and system states for the generator (eg Grid Connected vs Islanded, HON, HOF, and any alternative voltage or frequency control modes) as advised by the Network Service Provider.
7. Where new units are added to existing sites, tests are only required to be completed for those units, and multiple unit configurations involving those units, unless otherwise advised by the Network Service Provider.
8. Tests at low power output levels must precede tests at higher power output levels

9. Tests with smaller step changes must precede larger step changes. Care must be taken not to excite large or prolonged oscillations in MW etc.
10. For tests S1A and S1B the VAr absorption must be limited so that field voltage does not go below 50% of its value at rated voltage and at no load (i.e. rated stator terminal voltage with the generating unit on open circuit).
11. For test S1B the VAr load must not allow stator terminal voltage to exceed 8% overvoltage (i.e. 108% of rated value) as a result of the applied change.
12. For tests S1A and S1B, the instantaneous overvoltage protection must be operative and set at an agreed level greater than or equal to 10% overvoltage.
13. For test S1B, it may be easier to use AVR control first and then change to manual (provided the change is "bumpless") before the unit trips.
14. For test S9, care has to be taken not to excite electromechanical resonances (e.g. poorly damped MW swings) if the machine is on line.
15. For test S10 equipment characteristics may require the changes be varied from the nominal values given. Larger changes may be considered in order to more accurately determine equipment performance.
16. For test S5 a positive step is applied of X% from the sub-OEL value. But for test S6 a –Y% step from the sub-UEL value as shown in Figure A11.2 is required.

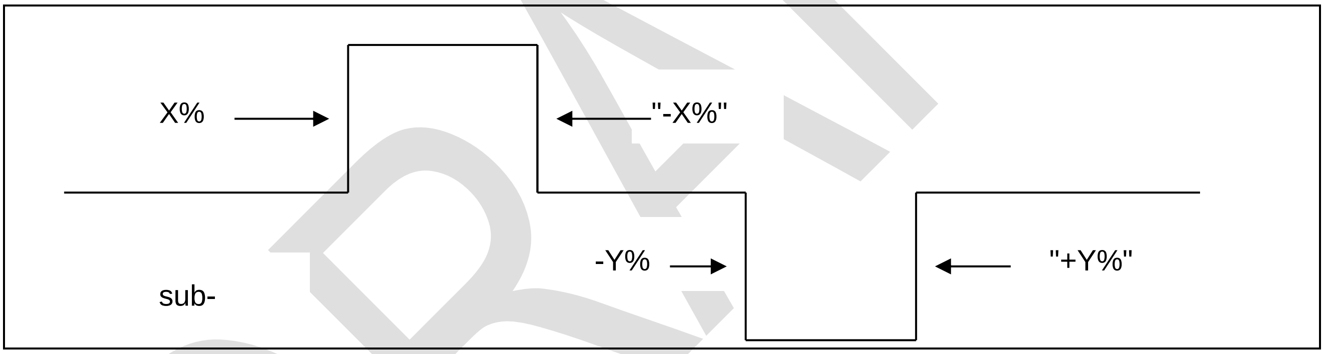

Figure A11.2 - Application of Step Signal

17. For a renewable energy hub the *Network Service Provider* will require tests at an appropriate number of hold points with each hold point expressed as % of the total generation capacity connected to the hub.
18. Any other tests to demonstrate compliance with a declared or registered equipment performance characteristic may be specified by the *Network Service Provider*.

ATTACHMENT 12 TESTING AND COMMISSIONING OF SMALL POWER STATIONS (<10 MW) CONNECTED

A12.1 Application

This attachment specifies the specific requirements for the certification, testing and commissioning of *generating units* connecting to the *distribution system* in accordance with section 3.4 and for which the provisions of section 4.2 apply.

A12.2 Certification

The *Generator* must provide certification by a chartered professional engineer with National Professional Engineers' Register Standing in relevant areas of expertise that the facilities comply with the *Rules*, the relevant *connection agreement*, good engineering practice and relevant standards. The certification must confirm that the following have been verified:

1. The single line diagram approved by the *Network Service Provider* has been checked and accurately reflects the installed electrical system. A SLD referring to the final/commissioned system signed off by a chartered professional engineer is sufficient to meet this requirement;
2. All required switches present and operate correctly as per the single line diagram. Provision of a checklist of all switches, their ratings, test methods and test results, as well as overcurrent and earth fault protection settings (where applicable) is sufficient to meet this requirement;
3. The specified *generation facility* is the only source of power that can be operated in parallel with the *distribution network*. Confirmation signed off by a chartered professional engineer that documentation provided specifies all generation sources attaching to the network at the nominated connection point is sufficient to meet this requirement;
4. The earthing systems complies with the applicable Australian Standards and International Standards including those listed in clause A12.9 of these *Rules* and do not rely upon the *Network Service Provider's* earthing system. Documentation signed off by a chartered professional engineer showing how earthing compliance is achieved is sufficient to meet this requirement;
5. Electrical *equipment* is adequately rated to withstand specified *network* fault levels. Provision of a checklist of all equipment and materials used along with their ratings is sufficient to meet this requirement;
6. All *protection apparatus* (that serves a *network protection* function, including backup function) complies with IEC 60255 and has been correctly installed and tested. Interlocking systems specified in the *connection agreement* have been correctly installed and tested. Provision of the following documentation is sufficient to meet this requirement, outlining details for:
   - i. Protection Apparatus:

     Copy of settings for protection relay/s and test results including actual trip or operation times.

     Copy of settings for inverter (if applicable).

     Copy of Type test reports to AS/NZS 4777 for inverters in accordance with section 3.5.3(d).
   - ii. Test equipment used:

List of equipment used for the testing of each protection apparatus installed as well as the functions tested. (Note also include calibration validity for test equipment.). Additionally, the following information is to be included.

Test method:

Date and time of testing:

Duration of testing:

iii. Interlocking System (if required);

7. The islanding *protection* operates correctly and *disconnects* the small *power station* from the *network* within 2 seconds. Provision of documentation in line with item 6 is sufficient to meet this requirement;
8. Synchronising and auto-changeover *equipment* has been correctly installed and tested. Provision of documentation in line with item 6 is sufficient to meet this requirement;
9. The delay in reconnection following restoration of normal *supply* is greater than 1 minute. Provision of documentation in line with item 6 is sufficient to meet this requirement;
10. The *protection* settings specified in the *connection agreement* have been approved by the *Network Service Provider* and are such that satisfactory coordination is achieved with the *Network Service Provider's protection systems*. Provision of a list of all protection equipment, the associated settings in the *connection agreement*, and the date and time each final setting was checked, as well as a check list to demonstrate how satisfactory coordination is achieved with the *Network Service Provider's* protection systems is sufficient to meet this requirement;
11. Provision has been made to minimise the risk of injury to personnel or damage to equipment that may be caused by an out-of-synchronism fault. Provision of the details of assessment and the date and time that the site was assessed is sufficient to meet this requirement. (Note this is typically not applicable to inverter-connected embedded generation);
12. Control systems have been implemented to maintain voltage, active power flow and reactive power flow requirements for the connection point as specified in the *connection agreement*. Provision of the following details (as applicable) is sufficient to meet this requirement:

    Test equipment used

    Test method

    Date and time of testing;

13. Systems or procedures are in place such that the testing, commissioning, operation and maintenance requirements specified in the Rules and the *connection agreement* are adhered to. Provision of confirmation that these are in place and verified with the customer and completion of schedule B and the signed Technical Schedules are sufficient to meet this requirement; and
14. Operational settings as specified. Provision of a list of all other equipment and settings and date and time of final setting check (i.e. ensuring all requirements of schedule A are met) is sufficient to meet this requirement. *Operational details affecting HP network – e.g. continuous parallel or timed operation, export limits, power factors etc.* (for protection equipment refer to items 6-9 above for requirements).

A12.3 Pre-commissioning

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

A12.4 Testing and Commissioning Procedures

The commissioning of a *generating unit* shall include the checks and tests specified in clauses A12.5 to A12.14.

In addition, the *Network Service Provider* requires all compulsory tests and selected special tests specified in Attachment 11 to be completed as advised by the *Network Service Provider*.

A.12.5 Operating Procedures

- The single line diagram shall be checked to confirm that it accurately reflects the installed plant;
- The documented operating procedures agreed with the *Network Service Provider* and have been implemented as agreed;
- Naming, numbering and labelling of plant agreed with the *Network Service Provider* has been followed; and
- Operating personnel are familiar with the agreed operating procedures and all requirements to preserve the integrity of the *protection* settings and interlocks and the procedures for subsequent *changes* to settings.

A12.6 *Protection Systems*

- *Protection apparatus* has been manufactured and installed to required standards;
- The settings and functioning of *protection systems* required for the safety and integrity of the *distribution system* operate correctly (at various power levels) and coordinate with the *Network Service Provider's protection systems*. This will include the correct operation of the *protection systems* specified in the *connection agreement* and, in particular,
- islanding *protection* and coordination with automatic reclosers export/import limiting *protection*;
- automatic changeover schemes; and
- fail-safe *generator* shutdown for auxiliary *supply* failure or loss of *distribution system supply;* and
- Any required *security* measures for *protection* settings are in place.

A12.7 Switchgear Installations

- Switchgear, instrument *transformers* and cabling have been manufactured, installed and tested to required standards.

A12.8 *Transformers*

- *Transformer(s)* has been installed and tested to required standards; and
- *Transformer* parameters (nameplate inspection) are as specified and there is correct functioning of on-load tap changing (when supplied).

A12.9 Earthing

- The earthing systems do not rely upon the *Network Service Provider's* earthing system.
- The earthing systems comply with, as applicable:
    - AS/NZS 3000
    - ENA EG(0)

- ENA EG(1)
- AS/NZS 2067
- AS/NZS 60479.1
- AS/NZS 4853
- AS/NZS 1768
- IEEE Standard 80 - 2013 IEEE Guide for Safety in AC Substation Grounding

A12.10 *Generating Units*

A12.10.1 Unsynchronised/ disconnected

- *Generating unit* parameters are as specified (nameplate inspection);
- *Generating units* have been manufactured to meet the requirements of the *Rules* for riding through *power system* disturbances;
- Earthing arrangements of the generating unit are as specified;
- Correct functioning of automatic *voltage* regulator for step *changes* in error signals (when specified);
- Achievement of required automatic *voltage* regulator response time (when specified); and
- Correct functioning of automatic synchronising *equipment* prior to *synchronisation*.

A.12.10.2 Voltage Changes

- *Voltage* transients at the *connection point* on connection are within specified limits; and
- Step *changes* in *voltage* on connection and *disconnection* (both before and after tap-changing) are within required limits.

A12.10.3 Synchronous *Generating Units*

- The *generating unit* is capable of specified sustained output of *real power* (when required);
- The *generating unit* is capable of required sustained *generation* and absorption of *reactive power*, (when required);
- Correct operation of over- and under-excitation limiters (when required); and
- Response time in constant *power factor* mode is within limits (when required).

A.12.10.4 Asynchronous Generating Units

- Starting inrush current is within specified limits;
- *Power factor* during starting and normal operation is within specified limits; and
- Rating and correct operation *of reactive power* compensation *equipment.*

A.12.10.5 Inverter connected Generating Units

- *Power factor* during starting and normal operation is within specified limits; and
- Rating and correct operation of *reactive power* compensation *equipment*.

A.12.10.6 Harmonics and Flicker

- *Network* flicker and harmonics levels before and after connection and confirmation that limits have not been exceeded (not required for directly *connected* rotating machines)**.**

A12.10.7 Additional Requirement for Wind Farms

- The level of variation in the output of a wind *generating unit* or *wind farm* is within the limits specified in the *connection agreement*.

A12.11 Interlocks and Intertripping

- Correct operation of interlocks, check synchronising, remote control, permissive interlocking and intertripping.

A12.12 Voice and Data Communications

- Correct operation of primary and back up voice and data communications systems.

A12.13 Signage and Labelling

- Signage and labelling comply with that specified in the relevant *connection agreement*.

A12.14 Additional Installation Specific Tests

- The *Network Service Provider* may specify additional installation specific tests and inspections in respect of the physical and functional parameters that are relevant for parallel operation of the small *power station* and coordination with the *distribution system*.

A12.15 Routine Testing

- The *Generator* must test *generating unit protection systems*, including backup functions, at regular intervals not exceeding 3 years for unmanned sites and 4 years for manned sites and keep records of such tests.
- Where in-built inverter *protection systems* compliant with *AS* 4777 requirements are permitted in small power stations with an aggregate rating of but less than 1000 kVA, these *protection systems* must be tested for correct functioning at regular intervals not exceeding 5 years. This testing must be in accordance with the most recent version of Horizon Power standard HPC-9FJ-12-0001-2012 *Technical Requirements for Renewable Energy Systems Connected to the Low Voltage (LV) Network via Inverters*. Where smoothing systems are installed, these shall be tested annually to the afore-mentioned standard. The *User* must arrange for a suitably qualified person to conduct and certify the tests and provide the certified results to the *Network Service Provider* upon request.

A12.16 Non-routine Testing

- The *Network Service Provider* may inspect and test the small *power station* from to re-confirm its correct operation and continued compliance with the *Rules*, *connection agreement*, good engineering practice and relevant standards. In the event that the *Network Service Provider* considers that the installation poses a threat to safety, to *quality of supply* or to the integrity of the *distribution system* it may *disconnect* the *generating equipment*.

ATTACHMENT 13 STANDARD PRIMARY PLANT RATINGS

All new primary plant shall be purchased in accordance with the minimum ratings specified in the tables below. For uprate/extension projects the *Network Service Provider* will specify the minimum requirements for each particular location.

These tables shall be read in conjunction with the following notes.

Table A13.1 - Standard Distribution Equipment Ratings

		System Voltage			
		33 kV	**22 kV**	**11 kV**	**6.6 kV**
Rated Voltage (kV rms)		36	24	12	7.2
1 Minute Power Frequency Withstand Voltage (kV rms)		70	50	28	20
Lightning Impulse Withstand Voltage across open switching device (kV Peak)	outdoor	200	150	95	60
	indoor	170	125	75	60
Normal Current (Amps rms):					
(a) Busbar Rating		1250	1250	2500	2000
(b) Line/Feeder Circuit Rating		630	630	800	800
(c) Transformer Circuit Rating		1250	1250	2000	2000
Short Time Withstand Current / Short Circuit Breaking Current (kA rms)		13.1	16	25	21.9
X/R ratio for DC component		As per *AS* 62271.100	25	25	As per *AS* 62271.100
Short Circuit Duration (s)		3	3	3	3

Table A13.2 Standard Zone Substation Ratings

System Voltage		132 kV	66 kV	33 kV	22 kV		11 kV
Rated Voltage (kV rms)		145	72.5	36	24		12
1 Minute Power Frequency Withstand Voltage (kV rms)		275	140	70	50		28
Lighting Impulse Withstand Voltage across open switching device (kV Peak)	outdoor	650	325	200	150		95
	indoor	550	325	170	125		75
Normal Current (Amps rms):						**6.6 kV or 11 kV**	
(a) Busbar Rating		1600	1250	1250	1250	2000	2500
(b) Line/Feeder Circuit Rating		1600	1250	630	630	800	800
(c) Transformer Circuit Rating		630	630	1250	1250	2000	2000
Short Time Withstand Current / Short Circuit Breaking Current (kA rms)		40	25	16	16	25	25
DC component as per *AS* 62271.100 (Figure 9)		Generally τ = 45ms curve, but must be confirmed for each site.					
Short Circuit Duration (s)		1	3	3	3		3

Table A13.3 Standard Terminal Station Ratings

System Voltage	330 kV	220 kV	132 kV		66 kV
Rated Voltage (kV rms)	362	245	145		72.5
1 Minute Power Frequency Withstand Voltage (kV rms)	520	460	275		140
Lighting Impulse Withstand Voltage across open switching device (kV Peak)	1175	1050	650		325
Switching Impulse Withstand Voltage (kV, Peak)	950	-	-		-
Normal Current (Amps rms):			**330 or 132 kV**	**132 or 66 kV**	
(a) Busbar Rating	3150	2500	3150	2500	1250
(b) 1 & ½ CB Bay Rating	2500	1250	2500		-
(c) Line Circuit Rating	2000	1250	1600		1250
(d) Transformer Circuit Rating	1250	1250	2500	1600	1250
Short Time Withstand Current / Short Circuit Breaking Current (kA rms)	50	25	40		25
DC component as per AS 62271.100 (Figure 9)	Generally τ = 45 ms curve, but must be confirmed for each site.				
Short Circuit Duration (s)	1	1	1		3

In addition to the above,

1. All components in the circuit shall meet the above minimum requirements.
2. The minimum ratings required for the generator circuits are not covered by this document. Please consult *Network Service Provider* about the minimum ratings for this application.
3. For applications in zone substations (table A13.2) where 22 kV plant will be initially operated at 6.6 kV or 11 kV, additional *current ratings* are defined above (shaded).

ATTACHMENT 14 RATING OF OVERHEAD EARTH WIRES, PHASE CONDUCTORS AND EARTH GRIDS

The minimum required clearing times and design fault ratings for the rating of overhead earth wires, phase conductors and earth grids at terminal stations and zone substations, are shown in the following table. These ratings include allowances for the extra heating effect of the DC offset.

Table A14.1 - Required Terminal / Zone Substation Plant Ratings

Overhead Earth Wires, Phase Conductors, Earth Grids						
		System Voltage				
		330 kV	**220 kV**	**132 kV**		**66 kV**
				Terminal	**Zone**	
Overhead Earth Wires, Phase Conductors & Earth Grids	**Short Time Withstand Current (kA)**	56	28	45	45	27
Overhead Earth Wires	**Short Time Withstand (ms)**	200	200	230	230	400
Phase Conductors	**Short Time Withstand (ms)**	270	370	280	400	1000
Earth Grids	**Short Time Withstand (ms)**	500	500	500	500	1000

NOTES:

- These ratings are applicable at the terminal/zone substation only, as the fault level and DC offset reduce significantly as the distance between the terminal/zone substation and the fault increases.
- For terminal/zone substations with high double phase to earth fault levels, the ratings in the table may need to be increased.
- The earthing system shall be designed in accordance with relevant standards, including AS 2067, and shall include N-1 redundancy for earth conductors and earth connections.
- Overhead earth wires for railway crossings shall meet the requirements of phase conductors as noted in Table A14.1 (for 132 kV this shall be the more onerous of the two values stated).
- All OPGW earth wires are to be designed to withstand a fault cleared in local backup time (LBU) to prevent damage to the optic fibre.
- In some country areas a lower standard fault level rating could be applied. Such cases will be a subject to individual review and individual approval for zone substations in the country areas. Please consult *Network Service Provider* for a lower fault level approval before proceeding with any plans or application.

The fault currents provided are the ultimate design fault levels required to ensure that plant will meet the thermal duty imposed by the *Network Service Providers* standard ratings, taking into account the extra heating effect of the DC offset (X/R).

ATTACHMENT 15 REVISION INFORMATION

Informative - for Horizon Power use only.

Horizon Power has endeavoured to provide standards of the highest quality and would appreciate notification if any errors are found or even queries raised.

Each Standard makes use of its own comment sheet which is maintained throughout the life of the standard, which lists all comments made by stakeholders regarding the standard.

The Document **HPC-9DJ-01-0001-COM** found in **DM# 1528623**, can be used to record any errors or queries found in or pertaining to this standard. This comment sheet will be referred to each time the standard is updated.

Date	Rev No.	Notes
30/10/2013	0	Original Issue
31/03/2017	1	First revision – refer to comments sheet for changes.
5/08/2020	2	Second revision – Re-authorisation of Rules
14/06/2022	3	Third revision

The changes between this revision (revision 3) and the previous revision include:

- Clarified that the *Network Service Provider* obligation to permit and participate in commissioning of equipment applies to connections on both the transmission and distribution systems (clause 1.8.2)
- Clarified that *frequency* ride through requirements for *generating units* and *power stations* >10 MW and connected to the *Pilbara Grid* (subclause 2.2.1.1(e))
- Clarified *load shedding* arrangements and *frequency* standards for *non interconnected systems* (clause 2.2.1.2)
- Clarified that various technical requirement for the *Pilbara Grid* are specified in the *Harmonised Technical Rules* (subclauses 2.2.2(a), 2.2.10(a), and section 3.1)
- Revised the *steady state power frequency voltage* requirements for *non interconnected systems* to align with AS 61000.3.100 (2011) (clause 2.2.2)
- Revised the temporary over-*voltage* requirements for *non interconnected systems* to align with contemporary practice as reflected in the Western Power Technical Rules (clause 2.2.10)
- Removed section 2.4 (in revision 2 of these *Rules*) to allow the *Network Service Provider* to determine appropriate *load shedding* settings.
- Clarified the use of automatic control of *pre-emptive load shedding* relays by the *Network Service Provider* in managing power system performance (clause 2.3.2).
- Requirement for the *Network Service Provider* to develop Network Modelling procedure added (clause 2.3.7.1) references to the Network Modelling Procedure added to clarify modelling requitements (clause 3.2.4 and 3.3.9, and Attachment 6 and 10) with detailed moved to the Network Modelling Procedure.
- Details regarding the application of the N-0 planning criteria moved to the network planning guideline (clause 2.5.3 in revision 2 of the *Technical Rules* deleted)
- Discretion provided to the *Network Service Provider* to consider maximum fault current limits that differ from those specified in these *Rules* (subclause 2.4.5(b))

- Upper range of small generating systems for which more onerous requirements may not apply increased from 150 kVA to 200 kVA to align with AS/NZ 4777 (clauses 2.5.2, 3.4.5, 3.4.10.1, 3.4.10.3)
- Clarified the applicable maximum fault clearance times (subclauses 2.5.4(h), (i) and (k))
- Guidance added to better explain which *User* technical requirements apply to different classes of connected equipment (subclause 3.1(d)).
- Simplified the applicability of sections 3.3 and 3.4 as applying to Generators based on their system capacity regardless of their connection to a transmission or distribution network. Consequently, the test schedule in Attachment 11 applies to Generators covered by section 3.3 and Attachment 12 testing and commissioning applies to Generator covered by section 3.4.
- Technical requirements for *Nominated IPP facilities* clarified by new section in chapter 3 (section 3.8)
- Clarification of when it may be appropriate for an unplanned trip of a large generating unit to result in disconnection of load (subclause 3.3.1(d))
- Clarification that the *Network Service Provider*s will specify the requirement to ride through RoCoF in *non interconnected systems* (subclause 3.3.3.2(e))
- Revised generating system frequency control requirements so that they can be applied to both large synchronous and large non-synchronous generating systems subject to energy source availability (subclause 3.3.4.4(e))
- Frequency response required from small generating systems specified (clause 3.4.9)
- Allow the *Network Service Provider* to consider accepting *protection* functions on smaller inverter connected *generating systems* that response to quantities measured at locations other than the *connection point* (clause 3.4.10.1)
- Requirements for connection of embedded *generating systems* simplified by referring to documents published by the *Network Service Provider*. Detailed guidance is provided in the “Low Voltage EG Connection Technical Requirements and the “Basic EG Connection Technical Requirements” (section 3.5)
- Updated the list of applicable earthing standards in Attachment 12.

- New section added to clarify technical requirements for *energy storage facilities* (section 3.7)
- Routine testing requirements extended to include testing of *control systems* for load following and dispatch (subclause 4.1.4(c))
- Clarified that notices issued by a *User* to the *Network Service Provider* in advance of proposed tests must include the name and contact information of the person responsible for test coordination (subclause 4.1.5(b))
- Clarified the tests required for *IPP facilities* (new clause 4.1.8)
- Clarified the requirements for commissioning of equipment in existing and new *IPP facilities* (new clauses 4.2.8 and 4.2.9)
- Clarified operational requirements to be met by *Nominated IPPs* and operational coordination between *Nominated IPPs* and the *Network Service Provider* (subclause 5.1(c), clauses 5.2.2, 5.2.3, 5.6.3, 5.6.4, 5.6.5, and section 5.7)
- Clarify requirement for generators to maintain a speech communication channel (subclause 5.9.2(b))
- Updated Glossary to include terms used in new sections and removed unused terms.
- Updated Attachment 4 to require large *generators* nominate the minimum short circuit ratio they require for stable operation and include data requirements for *inverter connected generating systems*.
- Revisions to Attachment 11 to rationalise and clarify testing requirements reflecting experience gained through recent generator commissioning and testing, including addition of pass criteria for each test and generalisation of some tests so that they better cater to technologies including BESS.
- Provided for tests in Attachment 11 to apply to generators covered by Attachment 12 requirements where appropriate as determined by the *Network Service Provider*.