Draft Technical Rules

for Submission
to the
Technical Rules Committee

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

PREFACE

Western Power Corporation (“Western Power”) was established on 1 January 1995 by the Electricity Corporation Act 1994 (the “Act”).

The Act requires that Western Power provides open access to capacity in its electricity transmission and distribution networks. The principal objective of open access is to facilitate competition in the energy industry by allowing independent generators to supply associated loads by utilising Western Power’s networks. The Electricity Networks Access Code 2004 “Access *Code*”, which superseded the initial regulations, covers transmission and distribution networks. Chapter 12 of the 2004 “*Access Code*” requires Western Power to publish a Technical Rules “*Rules*”. In addition, clause A6.1(m) requires Western Power to publish network planning criteria. The network planning criteria are included in this document.

This code covers the South West Interconnected System (SWIS).

These *Rules* details the technical requirements to be met by Western Power on its transmission and distribution networks and by Users who connect facilities to the transmission and distribution networks. In addition, the planning criteria to be applied to the network are contained within these *Rules*. Prospective Users or existing Users who wish to connect facilities to the transmission and distribution networks must first submit an access application to Western Power in accordance with the Access *Code*.

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

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

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

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1 GENERAL

This section defines the scope of the Technical Rules for both it's content and it's 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 the code.

1.1 AUTHORISATION

These *Technical Rules* ("*Rules*") are made under clause 4.1 of the Electricity Networks Access Code 2004 "*Access Code*"). The *Rules* set out:

(a) performance standards in respect of service quality parameters in relation to the *electricity transmission and distribution network*;

(b) the technical requirements which apply to the design or operation of *plant* or equipment *connected* to the *electricity transmission and distribution network*;

(c) requirements relating to the operation of the *electricity transmission network* (including the operation of the *electricity transmission and distribution network* in emergency situations or where there is a possibility of a person suffering injury);

(d) obligations on *user*s to test *plant* or equipment in order to demonstrate compliance with the technical requirements referred to in paragraph (b) and the operational requirements referred to in paragraph (c);

(e) procedures which apply if *Western Power* believes that a *user*'s *plant* or equipment does not comply with the requirements of the *Technical Rules*;

(f) procedures relating to the inspection of a *user*'s *plant* or equipment;

(g) procedures which apply to system tests carried out in relation to all or a part of the *electricity transmission and distribution network*;

(h) requirements which relate to control and *protection* settings for *plant* or equipment *connected* to the *electricity transmission and distribution network*;

(i) procedures which apply in the case of the commissioning and testing of new *plant* or equipment *connected* to the *electricity transmission and distribution network*;

(j) procedures which apply to the *disconnection* of *plant* or equipment from the *electricity transmission and distribution network*;

(k) procedures relating to the operation of *generating units* and other *plant* or equipment as part of or *connected* to the *electricity transmission and* *distribution network* (including the giving of *dispatch* instructions and compliance with those instructions);

(l) *metering* requirements in relation to *connection*s;

(m) the information which each *user* is required to provide *Western Power* in relation to the operation of *plant* or equipment *connected* to the *electricity transmission and distribution network* at the *user*'s *connection*s and how and when that information is to be provided;

(n) requirements in relation to under *frequency load shedding* with which *user*s must comply;

(o) any other matters relating to the *power system* (including the *electricity transmission and distribution network*) or *plant* or equipment *connected* directly or indirectly to the *electricity transmission and distribution network*; and

(p) the *network planning criteria* as required by clause A6.1(m) of the *Access Code*.

1.2 APPLICATION

In these *Technical Rules*, unless otherwise stated, a reference to *Western Power* refers to the Networks Business Unit of *Western Power* for the *South West Interconnected System. Other business units of Western Power are "users" under the Rules.*

- These *Rules* apply to:

(a) *Western Power* in its role as the operator of the *electricity transmission and distribution network*;

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

(c) every person to whom access to electricity transmission *and distribution* capacity is made available (including, without limitation, *Western Power* in its role as a trader of electricity and every person with whom *Western Power* has entered into an *access contract*); and

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

These *Rules* apply to all *plant* and equipment installed:

(a) in the *Western Power electricity transmission and distribution network*s; and

(b) by *user*s who are *connected* (either directly or indirectly) to the *electricity transmission and distribution network*s, and who impact on the operation and security of the *electricity transmission and distribution network*s, including *embedded generators*.

1.3 COMMENCEMENT

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

1.4 INTERPRETATION

In these *Rules*, words and phrases are defined in Attachment 1 and have the meanings given to them in Attachment 1, unless the contrary intention appears.

These *Rules* must be interpreted in accordance with the rules of interpretation set out in Attachment 2, unless the contrary intention appears.

1.5 WESTERN POWER AND *USERS* TO ACT REASONABLY

Subject to the Electricity Networks Access Code 2004 "*Access Code*", the *Western Power* and the *Users* must comply with these *Technical Rules*.

1.5.1 Exercising Discretion

To the extent that the *Western Power* and/or *Users* are granted any discretion under these *Technical Rules*, that discretion must be exercised reasonably and in a manner that is consistent with the objectives of these *Rules* and, in particular, consistent with *Good Electricity Industry Practice*.

1.5.2 Towards Each Other

The *Western Power* and a *User* must act reasonably towards each other in regard to these *Rules*, consistent with the objectives of these *Rules*.

1.6 DISPUTE RESOLUTION

All disputes concerning these *Rules* are to be resolved according to the clause 10.2 of the Electricity Networks Access Code 2004.

1.7 OBLIGATIONS

1.7.1 Obligations of *User*s

All *Users* must maintain and operate (or ensure their authorised *representatives* maintain and operate) all equipment that is part of their *facilities* in accordance with:

(a) relevant laws;
(b) the requirements of the *Access Code*;
(c) the requirements of these *Rules*; and
(d) *good electricity industry practice* and applicable *Australian Standards*.

Refer to clauses A3.71 to A3.78 (Liability and indemnity and Insurances) of the *Access Code*.

1.7.2 Obligations of *Western Power*

(a) *Western Power* must comply with the *power system* performance and *quality of supply* standards:

1) described in these *Rules*; and
2) in accordance with any *access contract* with a *User*.

(b) *Western Power* must:

(1) ensure that to the extent that a *connection point* relates to the *electricity transmission and distribution network,* every arrangement for *connection* with a *User* complies with all relevant provisions of these *Rules*;
(2) permit and participate in inspection and testing of *facilities* and equipment in accordance with clause 4.1;
(3) permit and participate in commissioning of *facilities* and equipment which is to be *connected* to its *network* in accordance with clause 4.2;
(4) advise a *User* with whom there is an *access contract* of any expected interruption characteristics at a *connection point* on or with its *network* so that the *User* may make alternative arrangements for *supply* during such interruptions, including negotiating for an alternative or backup *connection*; and
(5) use its reasonable endeavours to ensure that modelling data used for planning, design and operational purposes is complete and accurate and order tests in accordance with clause 4.1 where there are reasonable grounds to question the validity of data.

(c) *Western Power* must arrange for:

(1) management, maintenance and operation of the *electricity transmission and distribution network*s such that in the *satisfactory operating state*, electricity may be transferred continuously at a *connection point* up to the *agreed capability*;

(2) management, maintenance and operation of its *networks* to minimise the number and impact of interruptions to the *User* through adequate notification and consultation by using *good electricity industry practice*; and

(3) restoration of the *agreed capability* as soon as reasonably practicable following any interruption at a *connection point* on or with its *network*.

1.7.3 Obligations of *Users* With *Loads*

(a) Each *User* with a *load* must ensure that all *facilities* which are owned, operated or controlled by it and are associated with a *connection point* at all times comply with applicable requirements and conditions of *connection* for *loads:*

(1) as set out in clause 3.3; and

(2) in accordance with any *access contract* with *Western Power.*

(b) A User with a *load* must:

(1) comply with the reasonable requirements of *Western Power* in respect of design requirements of equipment proposed to be *connected* in accordance with clause 3.3;

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

(3) permit and participate in commissioning of *facilities* and equipment which is to be *connected* to a *network* location for the first time in accordance with clause 4.2;

(4) operate its *facilities* and equipment in accordance with any reasonable *direction* given by *Western Power*; and

(5) give notice of any intended permanent or extended time voluntary *disconnection* in accordance with clause 4.3.

1.7.4 Obligations of *Generators*

(a) A *Generator* must comply at all times with applicable requirements and conditions of *connection* for *generating units:*

(1) as set out in clause 3.2; and

(2) in accordance with any *access contract* with *Western Power.*

(b) Each *Generator* must:

(1) comply with the reasonable requirements of *Western Power* in respect of design requirements of equipment proposed to be *connected* to the *network* of *Western Power* in accordance with clause 3.2;

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

(3) permit and participate in commissioning of *facilities* and equipment which is to be *connected* to a *network* location for the first time in accordance with clause 4.2;

(4) operate *facilities* and equipment in accordance with any reasonable *direction* given by *Western Power*; and

(5) give notice of intended voluntary *disconnection* in accordance with clause 4.3.

1.8 VARIATIONS AND EXEMPTIONS FROM, AND AMENDMENTS TO, THE RULES

1.8.1 Variations and Exemptions to the Rules

Various clauses throughout these *Rules* permit variations or exemptions from *Rules* requirements to be granted to a *User* by reference to terms which include:

a) the requirements may be varied, but only with the agreement of *Western Power*;
b) unless otherwise agreed by *Western Power*;
c) unless otherwise agreed; and
d) except where specifically varied in an *access contract*.

In all cases, the requirements of these *Rules* can only be varied or waived for a *User* in accordance with the provisions of the *Access Code*. Any such variation or exemption must be granted for a specified period or indefinitely to *User(s)* by *Western Power*.

1.8.2 Amendments to the Rules

Western Power may amend these *Rules* only in accordance with the *Access Code*.

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

2.1 INTRODUCTION

This Section describes the technical performance requirements of the *transmission and distribution networks*, and the requirements for co-ordination between *Users* and *Western Power* to achieve these.

In particular circumstances, the requirements may be varied, but only with the agreement of *Western Power*. However, where it is intended to vary the requirements set down, it must be demonstrated that the variation will not adversely affect *Users* and *power system security*. Refer to Section 6 - *Derogation*s.

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 *Western Power*. These studies may be performed by the *User* or a third party, in which case, *Western Power* will require full details of the studies performed, including, assumptions made, results, conclusions and recommendations. However, acceptance of the studies performed by a *User* or a third party will be entirely at *Western Power's* discretion. Acceptance of *power system* studies by *Western Power* does not absolve *Users* of responsibility/liability for damages or losses incurred by others. *Western Power* reserves the right to perform its own studies and will provide details of such studies to the *User*. *Western Power* 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 the *Access Code* and these *Rules*.

2.2 POWER QUALITY

2.2.1 *Frequency* Variations

Western Power's nominal frequency of supply is 50 Hz.

The accumulated synchronous time error in Western Power networks is not expected to exceed 10 seconds.

Operation outside the range 47.0 to 52.5 Hz need not be taken into account by Western Power and Users in the design of connected plant which may be disconnected if this is necessary for the protection of that plant.

The frequency operating standards for Western Power transmission *and distribution* networks are summarised in Table 2.1 below.

Table 2.1 Western Power's Frequency Operating Standards for SWIS.

Condition	Frequency Band	Target Recovery Time
No disturbance: South West Island(1)	 49.8 to 50.2 Hz for 99% of time 49.5 to 50.5 Hz	- - -
Single contingency	48.75 to 51 Hz	49.8 to 50.2 Hz within 25 minutes For over-frequency events: 51.0 to 50.5 Hz within 2 minutes
Multiple Contingency	47.0 to 52.0 Hz	49. 8 to 50.2 Hz within 25 minutes For under-frequency events: 47.0 to 47.5 Hz within 10 seconds 47.5 to 48.0 Hz within 5 minutes 48.0 to 48.5 Hz within 15 minutes For over-frequency events: 52.0 to 51.5 Hz within 1 minute 51.5 to 51.0 Hz within 2 minutes 51.0 to 50.5 Hz within 5 minute

Note: *(1) – an island is formed when connection between parts of the interconnected network is broken. The frequency band is applied within an electrical island as it forms and after it has stabilised.*

Western Power will require the use of load shedding facilities (described in clause 2.4 in this section) to aid recovery of frequency to the range 49.5Hz to 50.5Hz. 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. Even with the formation of islands, each island in the power system, which contains generation, must have sufficient load shedding facilities in accordance with clause 2.4 to aid recovery of frequency to the range 49.5Hz to 50.5Hz.

2.2.2 Power Frequency *Voltage* Variations

Western Power must plan and design *extensions* of its *networks* and equipment for control of *voltage* such that the minimum steady state *voltage* on the *transmission and high voltage* *distribution network* will be 90% of nominal *voltage* and the maximum steady state *voltage* will be 110% of nominal *voltage*. For low voltage distribution network, steady state voltage must be within:

- ± 6% of the nominal voltage during normal conditions,
- ± 8% of the nominal voltage during maintenance conditions,
- ±10% of the nominal voltage during emergency conditions.

However, in some parts of the system other limits may be applied following detailed *load*-flow, fault, harmonics. and stability studies. Step changes in voltage levels resulting from switching operations shall not exceed the limits given in clause 2.6.1, Table 2.10.

A requirement for a target range of *voltage* magnitude at a *connection point* may be specified in *access contract*s. This may include a different target range under normal and post-contingency conditions (and how they may be required to vary with *loading*). Where more than one *User* is supplied such that independent control of *voltage* at their *connection points* is not possible a compromise target must be agreed by the relevant *Users*. Short-time variations within 5% of the target values must be considered in the design of *plant* by *Users.*

Short-circuits in different parts of the *network* cause "dips" in the power-*frequency* phase *voltage*s to values which will be dependent on the nature and location of the fault. During some faults, one or more of the phase to ground *voltage*s may fall to zero or may rise above the nominal *voltage* level. depends on the fault clearing times and duration of voltage recovery as determined by computer simulations. The results shall be presented in the form of the equivalent voltage excursion versus time curve at the intended connection point.

Western Power and *Users* must ensure that each *facility* that is part of a *transmission network or distribution network* is capable of continuous uninterrupted operation in the event that variations in *supply voltage* described in the previous paragraphs occur (other than when the *facility* is faulted).

2.2.3 Voltage fluctuations

Voltage fluctuation causes changes of the luminance of lamps which can create the visual phenomenon called flicker.

The requirements for connecting large fluctuating loads (producing flicker) to transmission and distribution network are set out in Australian / New Zealand Standard AS/ANZ 61000.3.7:2001.

The flicker severity is characterised by two quantities:

P_{st} - short-term flicker severity term (obtained for each 10 minute period)
P_{lt} - long-term flicker severity (obtained for each 2 hour period)

Under normal operating conditions flicker severity caused by voltage fluctuation in the transmission and distribution network should be within the planning levels shown in Table 2.2. for 99% of the time.

Table 2.2 Planning Levels for Flicker Severity

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

Notes:

1. *These values were chosen on the assumption that the transfer coefficients between MV or HV systems and LV systems is unity;*
2. *The planning levels in Table 2.2 are not intended to control flicker arising from uncontrollable events such as faults in the power system, etc.*
3. *For LV systems (415V) flicker will be evaluated in accordance with AS61000.3.5 Planning levels*

Measurements should be carried out according to Australian / New Zealand Standard AS/NZS 4376. From the P_{st} values measured during the observation week the Cumulative Probability Functions (CPF) of P_{st} and P_{lt} should be obtained and the percentiles $P_{st95\%}$, $P_{st99\%}$, $P_{lt95\%}$ and $P_{lt99\%}$ should be derived.

The 99% percentiles($P_{st99\%}$, $P_{lt99\%}$) should not exceed the planning levels in Table 2.2.

The 95% percentiles ($P_{st95\%}$, $P_{lt95\%}$) are useful for detecting abnormal results (e.g. due to thunderstorms). If the ratio between 99% and 95% percentiles is greater than 1.3 one should investigate the reason for the discrepancy.

The emission levels can be assessed by direct measurement or by calculation from the available data concerning the load and the system.

The emission level contribution for existing and new Users is subject to verification of compliance by *Western Power*.

Western Power must allocate emission limits in response to a connection inquiry or an application to connect and evaluate the acceptability for connection of fluctuating sources as follows:

(a) *automatic access standard:* Western Power must allocate emission limits no more onerous than the lesser of acceptance levels determined in accordance with either of the stage 1 or the stage 2 evaluation procedures defined in AS/ANZ 61000.3.7:2001; and

(b) minimum access standard: the determination by Western Power of acceptable emission limits must be undertaken in consultation with the party seeking *connection* using the stage 3 evaluation procedure defined in AS/ANZ 61000.3.7:2001.

The User is responsible for maintaining the emissions at the point of common coupling (PCC) below the limits specified by Western Power. Western Power is responsible for the overall control of disturbance levels under normal operating conditions in accordance with these *Rules*. The user is also responsible for ensuring that during their design process they design their plant to meet the requirements.

2.2.4 Voltage Waveform Distortion

The requirements for connecting large distorting loads (producing harmonics and/or interharmonics) to transmission network are set out in Australian / New Zealand Standard AS/ANZ 61000.3.6:2001. Equipment such as asymmetrical rectifiers, converters, half wave converters etc that result in DC components will not be allowed to connect to the network.

Users must ensure all their plant and equipment is designed to withstand without damage or reduction in life expectancy 100% of the limits

Under normal operating condition harmonic voltage in the transmission network should not exceed the planning levels shown in Tables 2.3 & 2.4.

Table 2.3 Transmission planning levels for harmonic voltage in networks with system voltage less or equal 35kV (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 2.4 Transmission planning levels for harmonic voltage in networks with system voltage above 35kV (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 Tables 2.3 & 2.4 are not intended to control harmonics arising from uncontrollable events such as geomagnetic storms, etc.*

2. *The total harmonic distortion (THD) is calculated from the expression*

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

where

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

U_1 *- fundamental voltage;*

U_h *- harmonic voltage of order h expressed in percent of the nominal voltage;*

In certain cases *interharmonic* voltages (where the frequencies are not integer multiples of the fundamental) give rise to flicker or cause interference in ripple control systems and therefore have to be restricted. In Western Power's transmission networks the planning level for *interharmonic* voltages is equal to 0.2 %.

Measurements of harmonics and *interharmonics* should be carried out according to Australian / New Zealand Standard AS/NZS 61000.4

– The maximum weekly value of THD and individual harmonics / *interharmonics* should not exceed the planning levels;

Harmonics are generally measured up to h=40. In most cases this is adequate for the evaluation of distortion effects of power disturbances. However, higher order harmonics up to 100^{th} order can be an important concern in some cases.

The distortion emission levels should be assessed either by direct measurement or by calculation from the available data concerning the load and the system.

The distortion emission level contribution is subject to verification of compliance by *Western Power*.

Western Power must allocate emission limits in response to a connection inquiry or an application to connect and evaluate the acceptability for connection of distorting sources as follows:

(c) *automatic access standard:* Western Power must allocate emission limits no more onerous than the lesser of acceptance levels determined in accordance with either of the stage 1 or the stage 2 evaluation procedures defined in AS/ANZ 61000.3.6:2001; and

(d) minimum access standard: the determination by Western Power of acceptable emission limits must be undertaken in consultation with the party seeking *connection* using the stage 3 evaluation procedure defined in AS/ANZ 61000.3.6:2001.

The User is responsible for maintaining the total load harmonic current emissions at the PCC below the limits specified here. Western Power is responsible for the overall control of distortion levels under normal operating conditions in accordance with these *Rules*. It is the users responsibility to ensure the limits are met at design and during the life of the connection.

2.2.5 Voltage Unbalance

Western Power must balance the phases of its network and User must balance the current drawn in each phase at each of its connection points so as to achieve average levels of negative sequence voltage at all connection points that are equal to or less than the values set out in Table 2.5 below.

Users must ensure that all their *plant* and equipment is designed to withstand without damage or reduction in life expectancy 100% of the limits as specified in Table 2.5.

Responsibility of *Western Power* for *voltage* unbalance outside 100% of the limits specified in Table 2.5 must be limited to *voltage* unbalance caused by *network* assets and the pursuit of all measures available under the *Access Code* and these *Rules* to remedy the situation in respect of *Users* whose *plant* does not perform to the standards specified in this clause 2.2.5.

Table 2.5 Transmission 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

Note:

1. *The limits in Table 2.5 are not intended to control negative sequence voltages occurring for a short period as the result of faults, single pole interruptions, line switching, transformer energisation, shunt capacitor bank energisation or shunt reactor energisation within the transmission network.*

2.2.6 Electromagnetic Interference

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

2.2.7 Assessment of Power Quality

The power quality parameter measurements to assess compliance with these *Technical Rules* are to be taken as specified in Table 2.6 below:

Table 2.6 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	Periodically	one week	10 minutes
Short-term flicker severity	P_{st}	Periodically	one week	10 minutes
Long-term flicker severity	P_{lt}	Periodically	one week	2 hours
Harmonic / interharmonic voltage and voltage THD	mean rms value over interval	Periodically	one week	10 minutes
Negative sequence voltage	mean rms value over interval	Periodically	one week	10 minutes

Notes:

1. *The power quality parameters except fundamental frequency and negative sequence voltage are to be measured in each phase of a three-phase system;*
2. *The fundamental frequency is 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 can be used to assess Western Power's network and User system performance during specific events.*

2.3 STABILITY

Users must cooperate with Western Power to achieve stable operation of the power system and appropriate measures must be taken to prevent instability. Such preventive measures, including provision of any emergency controls as reasonably required, must be identified and provided for at the planning and design stage.
Power system stability is 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.

Stability is a condition of equilibrium between opposing forces. Depending of the network topology, system operating condition and the form of disturbance, different sets of opposing forces may experience sustained imbalance leading to different forms of instability.

The classification of power system stability in this clause relies to a large extent on Joint IEEE / CIGRE Task Force on Stability Terms and Definitions report (CIGRE brochure No. 231, June 2003) and is illustrated in Figure 2.0. The classification indicates the main system variable in which instability can be observed.

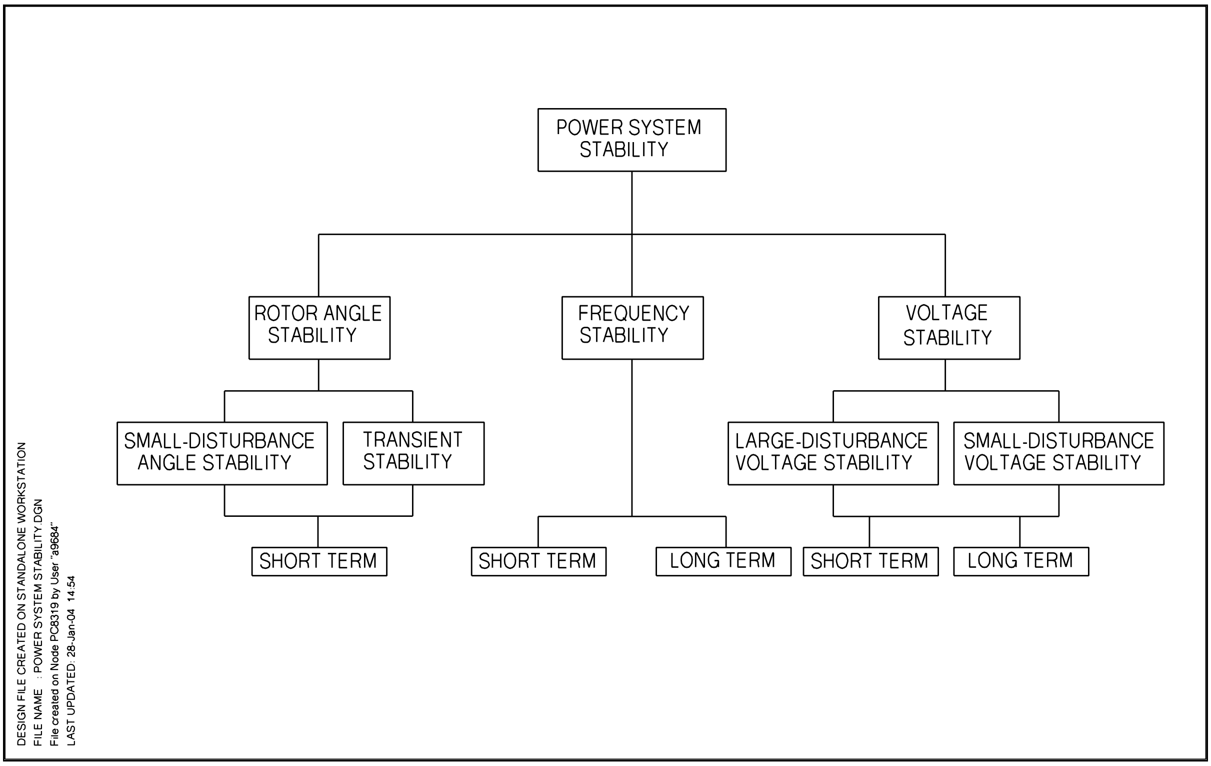

Figure 2.0 – Classification of power system stability.

2.3.1 Rotor Angle Stability

Rotor angle stability is the ability of synchronous machines of an interconnected power system to remain in synchronism after being subjected to a disturbance. Instability that may result occurs in the form of increasing angular swings of some generators leading to their loss of synchronism with other generators. Loss of synchronism can occur between one machine and the rest of the system, or between groups of machines, with synchronism maintained within each group after separating from each other. There are two forms of rotor angle stability: small-disturbance (or small-signal) and transient stability.

Small-disturbance (or small-signal) rotor angle stability is the ability of the power system to maintain synchronism under small disturbances. The disturbances are considered to be sufficiently small if linearization of system equations is permissible for purposes of analysis. Small disturbances may be caused by routine switching (for example, line or capacitor), transformer tap changes, generator AVR setpoint changes, etc.

Large-disturbance rotor angle stability or transient stability is 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 generator rotor angles and is influenced by the non-linear power-angle relationship.

The rotor angle stability criterion is:

> All generators connected to the power system shall remain in synchronism.

For the mandatory safety margin that takes into account errors associated with protection and circuit breaker operating times, refer to Attachment 1 – Glossary, definition of the *total fault clearance time*.

System disturbances are as specified in clause 2.3.4.1.

Measures must be implemented to prevent rotor angle instability from occurring. Such measures include, but are not limited to:

1) All transmission and distribution network faults must be cleared in sufficient time to prevent rotor angle instability.

2) The level of power transfer must not exceed 95% of the rotor angle stability limit.

The rotor angle stability problem involves the study of the electro-mechanical oscillations inherent in power systems, refer to clause 2.3.1.1 Damping of power system oscillations.

2.3.1.1 Damping of Power System Oscillations

Rotor angle instability may occur after a few swings due to poor damping of power system oscillations. All system oscillations, originating from either system electro-mechanical characteristics, electro-magnetic effect or non-linearity of system components, triggered by any small or large disturbance in the power system must be well damped and the power system must be able to return to a stable operating state following the disturbance. The following criteria are to be met.

a) The damping ratio of the oscillations should be at least 0.1.

b) For electro-mechanical oscillations as a result of small disturbances, the damping ratio of the oscillation should be at least 0.5.

c) In addition to a) and b), the halving time of any oscillations shall not exceed 5 seconds.

Appropriate actions should be taken to prevent oscillations outside the above criteria.

2.3.2 Frequency Stability

Frequency stability is the ability of a power system to maintain steady frequency following a severe system disturbance resulting 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 and/or loads.

Severe system disturbances may lead to the break-up of the system and its separation into islands. Stability in this case is a question of whether or not each island will reach a state of operating equilibrium with minimal unintentional loss of load. It is determined by the overall response of the island as evidenced by its mean frequency, rather than relative motion of machines.

Various control actions should be used to restore the balance between load and generation in order to arrest the frequency excursion to within the plant capability of clause 3.2.4.3 and to return the frequency to within the normal operating limits of clause 2.2.1. They include but are not limited to the use of:

1. spinning reserve,
2. under frequency load shedding (UFLS), and

2.3.3 Voltage Stability

Voltage stability is the ability of a power system to maintain steady voltages at all busses in the system 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 busses. A possible outcome of voltage instability is loss of load in the area, or tripping of transmission lines and other elements, including generators, by their protective systems leading to cascading outages.

The term *voltage collapse* is also often used. It is the process by which the sequence of events accompanying voltage instability leads to a blackout or abnormally low voltages in a significant part of the power system. *Voltage collapse* is associated with a deficit of reactive power.

2.3.3.1 Voltage Stability Criterion.

All necessary steps should be taken to ensure that:

> Voltage instability does not occur for the most onerous system disturbance consistent with clauses 2.5 and 2.6.5.

Reactive power reserve requirements to reduce the risk of voltage collapse are given in clause 2.6.5.

2.3.3.2 Temporary Over-voltages

> Temporary AC over-voltages should not exceed the time duration limits given in Figure 2.1

For the purpose of this clause, the voltage of supply is measured as the RMS phase voltage.

2.3.3.3 Transient Overvoltages

Surge arresters must be used to ensure that the transient over-*voltage* seen by an item of *transmission and distribution plant* is limited to its impulse withstand level.

2.3.3.4 Transient Voltage Dip Criteria (TVD)

The transient voltage dip limits (following fault clearance), which may be used in assessing the network performance as a reference, are as follows.

a) In the metropolitan area, system transient voltages dips resulting from the power swings that follow a fault, should not drop below 75% of nominal operating voltage and shall not remain below 80% of nominal operating voltage for more than 400ms during the power swing.

b) In all country and remote areas, system transient voltages dips resulting from the power swings that follows a fault, should not drop below 70% of nominal operating voltage and shall not remain below 80% of nominal operating voltage for more than 800ms during the power swing.

c) In all metropolitan and country areas the post-transient voltage deviation limits shall be in accordance with the values specified in Table 2.10

Refer to Figure 2.2 for further details on a) and b).

Due consideration should be given to the Transient Voltage Dip limits to prevent motor loads being disconnected from the system by the undervoltage resulting from transient power swings.

2.3.3.5 Post-fault Voltage Recovery Limit

a) In the metropolitan area, transmission system voltages after a fault on the system is cleared shall recover to levels above 80% of nominal operating voltage within 400ms counting from the end of the fault clearance.

b) In all country and remote areas, transmission system voltages after a fault on the system is cleared shall recover to levels above 80% of nominal operating voltage within 800ms counting from the end of the fault clearance.

Refer to Figure 2.3 for further details.

Measures including those listed in clause 2.3.1 must be implemented to prevent post-fault voltage recovery from exceeding above limit.

2.3.4 Stability Assessment

General. We have classified power system stability in clauses 2.3.1, 2.3.2 and 2.3.3 to manage the complexity of the problem and for convenience in identifying forms and causes of instability, applying suitable analysis tools and developing corrective measures. In any given situation, however, any one form of instability may not occur in its pure form. It is therefore important that the overall stability of the system should always be kept in mind, and that solutions to stability problems of one category should not be at the expense of another.

Specifically. Each of the stability criteria stated in clauses 2.3.1, 2.3.2 and 2.3.3 must be satisfied under the worst credible system load and generation pattern, and the most severe credible contingency event arising from either,

a) A single credible contingency event consistent with the N-1 criterion of clause 2.5;

b) A double credible contingency event consistent with the N-2 criterion of clause 2.5.

These contingency events involve fault types specified in clause 2.3.4.1.

2.3.4.1 Fault Types to be Studied

The most severe disturbance that can occur at any location within the power system from the following fault types is to be used to determine the stability of the power system. The slower of the two main protection operating schemes should be used as the fault clearance time to determine the stability of the power system:

1) A three-phase-to-earth fault cleared by disconnection of the faulted component;
2) A single-phase-to-earth fault cleared by backup protection and the disconnection of the faulted component;
3) A single-phase-to-earth fault cleared, but after unsuccessful high-speed single-phase auto-reclosure onto persistent fault;
4) Sudden disconnection of a system component, e.g. a transmission line, a generation unit.

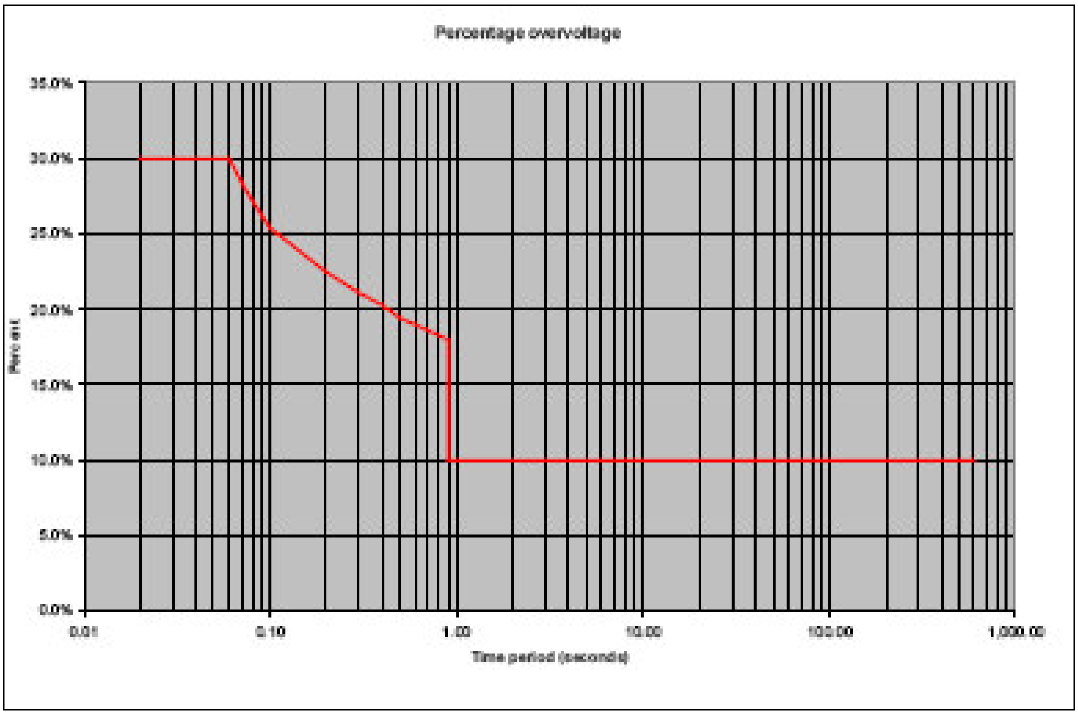

Figure 2.1 - Highest Acceptable Level and Duration of AC Temporary Over-Voltage

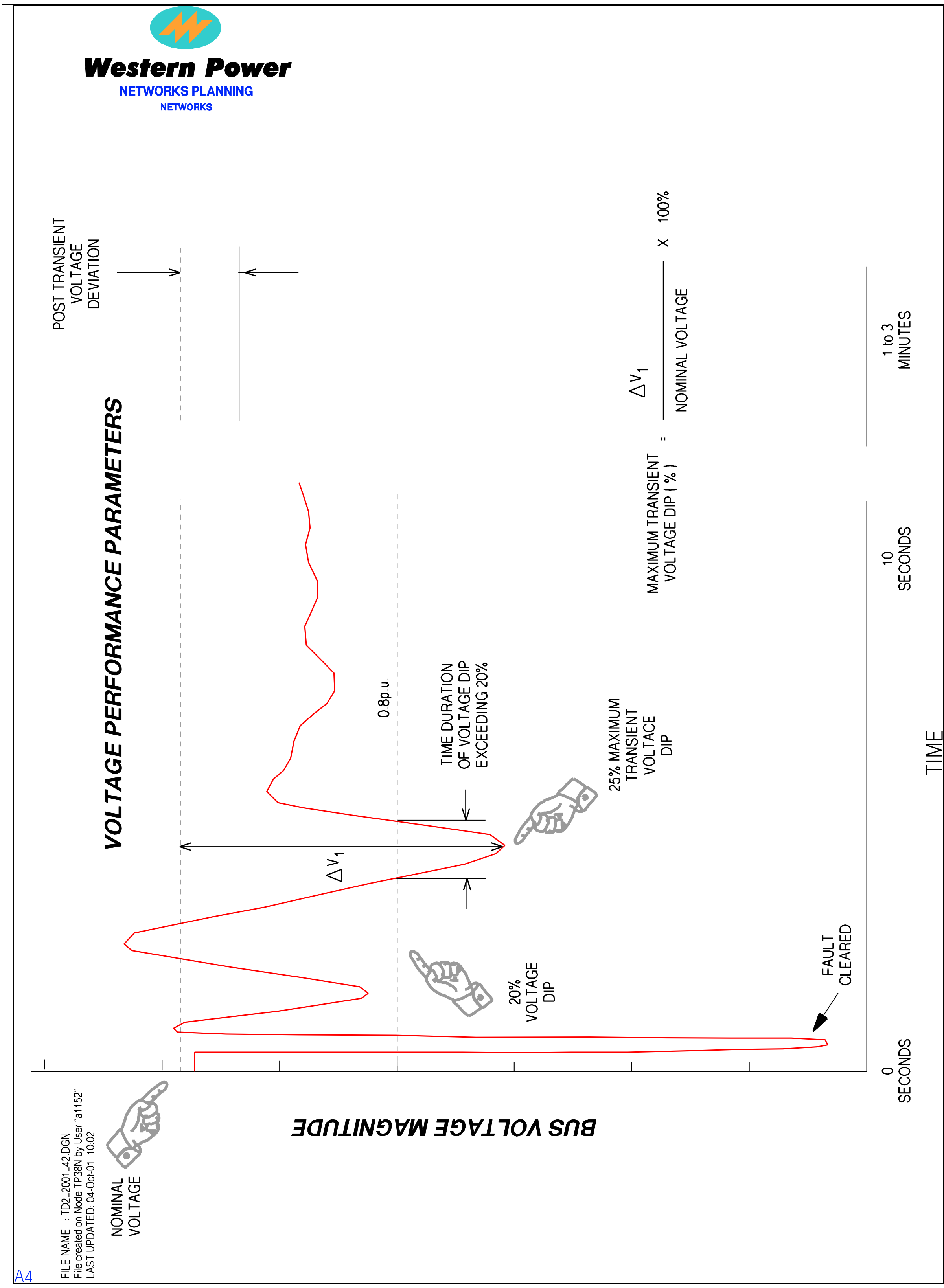

Figure 2.2. Transient voltage dip (TVD) criteria.

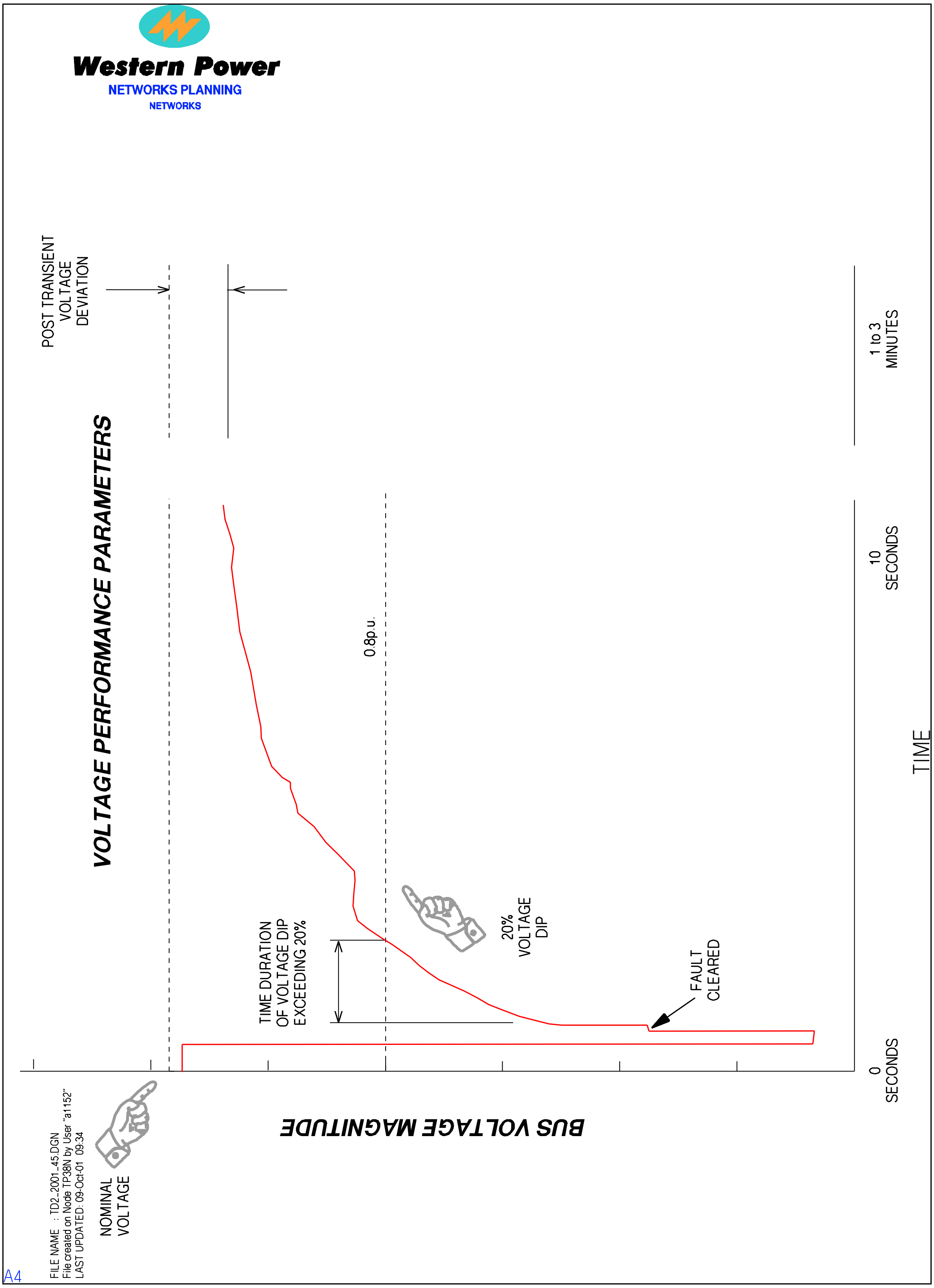

Figure 2.3 Transient voltage recovery (TVR) limits.

2.4 LOAD SHEDDING FACILITIES

2.4.1 *Load* to be Available for *Disconnection*

It is a requirement for *power system security* that up to 75% of the *power system load at* any time be available for *disconnection*:

(a) under the automatic control of under*frequency* relays; and

(b) under manual or automatic control from *control centre*s; and/or

(c) under the automatic control of under*voltage* relays.

In some circumstances, it may be necessary to have up to 90% of the *power system load*, or up to 90% of the *load* within a specific part of the *network*, available for automatic *disconnection*. *Western Power* will advise *User*s if this additional requirement is necessary.

Special *load shedding* arrangements may be required to be installed to cater for abnormal operating conditions.

Subject to clauses 5.3.3(c) and 5.3.3(d), arrangements for *load shedding* must be agreed between *Western Power* and *Users* and can include the opening of circuits in a *transmission* or *distribution network*. The settings of a *load shedding* scheme shall be in accordance with the existing settings outlined in clause 2.4.3, unless otherwise agreed by *Western Power*.

Western Power must specify, in the *access contract,* control and monitoring requirements to be provided by a *User* for *load shedding facilities*.

2.4.2 Installation and Testing of *Load Shedding Facilities*

Users must:

(a) provide, install, operate and maintain *facilities* for *load shedding* in respect of any *connection point*.

(b) co-operate with *Western Power* in conducting periodic functional testing of the *facilities*, which must not require *load* to be *disconnected*, provided *facilities* are available to test the scheme without shedding *load*.

(c) apply under*frequency* settings to relays as determined by *Western Power*.

(d) apply under*voltage* settings to relays as determined by *Western Power*.

2.4.3 Existing Settings of Under-*frequency Load Shedding* Schemes

The present settings for the *South West Interconnected System* under-*frequency load shedding* scheme are given in Table 2.7. The UFLS requirement and the settings specified in Table 2.7 are fully applicable to all User's loads. This includes loads in the User's system as long as the User's system, including its generation, is connected to the Western Power network.

Switchable *capacitor bank*s at *substation*s should also be shed in accordance with Table 2.7.

Table 2.7
Under-*Frequency Load Shedding* Scheme Settings for the *South West Interconnected System*

Stage	*Frequency* (Hz)	Time Delay (sec)	*Load* Shed (%)	Cumulative *Load* Shed (%)	Capacitor shed (%)	Cumulative Capacitor Shed (%)
1	48.75	0.4	15	15	10	10
2	48.50	0.4	15	30	15	25
3	48.25	0.4	15	45	20	45
4	48.00	0.4	15	60	25	70
5	47.75	0.4	15	75	30	100

2.5 RELIABILITY OF THE TRANSMISSION AND DISTRIBUTION NETWORKS

Reliability of a power system refers to the probability of its satisfactory operation over the long run. It denotes the ability to supply adequate electric service on a nearly continuous basis, with few interruptions over an extended time period.

The *reliability* criteria in this clause 2.5 apply only to the *electricity transmission* and *distribution networks* and not to *connection* assets. *Connection* assets will be designed in accordance with a *User's* requirements.

The contingency criteria to which the *transmission* and *distribution network* has been designed must be taken into account when assessing the impact of a *User's* installation on other *Users*, or the *power system.*

2.5.1 Transmission Networks

A fundamental reliability principle, that generally applies to all transmission plant in the power system, is that a single fault shall not cause disconnection of equipment beyond its fault clearing zone. Clearly, this principle does not apply to parts of the system designed to the (N-0) criterion or those protected by remedial action schemes.

Western Power will design the *reliability* of power supply of each *sub-network* of its *transmission networks* in accordance with the following criteria:

- N-0,
- N-1,
- N-2,
- CBD, or
- Zone Substation Power Transformers: 1% Risk and NCR.

2.5.1.1 N-0 Criterion

A section of a *network* designed to the N-0 criterion may result in the loss of all *load* in the area supplied by the *transmission sub-network* for the loss of a *transmission element*.

The N-0 criterion is applied to sub-networks and zone substations with a load of less than 20 MVA.

The N-0 criterion is also applied to the 220 kV network supplying the Eastern Goldfields Region.

For zone substation power transformers, load shedding following the loss of a power transformer is permissible. A further power transformer shall be installed if there is insufficient backup to supply loads via the distribution network system to allow transformer maintenance at off peak times.

2.5.1.2 N-2 Criterion

For the *sub-network* designed to operate with the N-2 criterion the *network* must be capable of withstanding coincident planned and unplanned *outages* of *transmission elements* listed in Table 2.8 at up to 80% of *peak load*. It is to be assumed that during the planned *outage*, generation has been rescheduled to mitigate the effect of the subsequent *outage*.

The N-2 contingency criterion applies to:

1. All aspects of the steady-state criteria in clause 2.6.
2. All aspects of the stability criteria in clause 2.3.

Table 2.8 Combinations of Transmission Elements Comprising a Double-Contingency (N-2 Criterion)

N-2 *Outages*
transmission line maintenance and *transmission* line

transformer maintenance and *transformer*
transformer maintenance and *transmission* line
busbar maintenance and *transmission* line
busbar maintenance and *transformer*
circuit breaker maintenance and *transmission* line
circuit breaker maintenance and *transformer*
circuit breaker maintenance and *busbar* loss
transmission line maintenance and *transformer*

N-2 criterion means that the consequences of coincident planned and unplanned *outages* of *transmission elements*, at or below 80% of *peak load*, will normally result in *supply* being maintained without loss of *load*, provided *generation* is rescheduled prior to the second *outage*.

In general, the bulk *transmission network* which interconnects the major *power stations* with the *transmission substations* will be designed to the N-2 criteria.

The N-2 criterion is applied to:

a) All 330kV lines, terminal stations and power stations, with the exception of the 330kV interconnection in the Bunbury load area.
b) All 132kV terminal stations in the Perth metropolitan area, and Muja power station 132kV substation.
c) All 132kV transmission lines that supply a sub-network comprising of more than 5 substations with total peak load exceeding 400MVA.
d) All power stations whose export to the transmission network exceeds 25% of the transmission network system peak.

For breaker fail events initiated by line or *transformer* faults, the operation of the *transmission sub-network* designed to the N-2 criterion must satisfy the steady state criteria at 80% of *peak load* without generation re-scheduling. All *transmission plant* is assumed to be in service prior to the event.

2.5.1.3 CBD Criterion

The CBD criterion currently applies to Milligan Street and Hay Street zone substations and connected networks. It may be extended in the future as the Perth Central Business District (CBD) grows. The Perth CBD Zone is defined in the Access Arrangement Document.

Individual zone substations in the CBD area shall be designed to the N-1 planning criterion, for the loss of any:

- One transmission line, or
- One power transformer.

After a momentary supply interruption, the supply to 100% of loads shall be restored within 30 seconds by automatic transfer of loads to neighbouring zone substations via distribution network. Spare capacity for this purpose shall be maintained.

Any group of zone substations in the CBD area shall be designed to the N-2 planning criterion for the loss of any:

- Two transmission lines,
- Two power transformers, or
- One transmission line and one power transformer.

After a short supply interruption, the supply to 100% of loads shall be restored via distribution network switching, for which spare feeder and zone substation capacity shall be made available.

2.5.1.4 Zone Substation Power Transformers

Zone substation power transformers are a special case as they form the boundary between transmission and distribution network. They are neither strictly N-1 or N-0.

Unlike other planning criteria that also apply to networks, there are two criteria that are applied exclusively to zone substation power transformers: the 1% Risk Criterion and NCR Criterion. They permit higher transformer utilisation than that permitted by the N-1 criterion, but lesser than that permitted by the N-0 criterion.

In contrast to the N-1 criterion, where transformers in a single zone substation provide backup for each other, the 1% Risk and NCR criteria are based on the idea of sharing a common spare transformer among a population of zone substation power transformers across a number of zone substations in a geographically confined area.

A trade off is limited load shedding risk, for as long as it takes to deploy and install a spare transformer. The acceptance of this risk determines the application of these two criteria.

The 1% Risk and NCR criteria apply to:

1. All aspects of the steady-state criteria in clause 2.6.
2. All aspects of the stability criteria in clause 2.3
3. All aspects of the *power quality* criteria in clause 2.2.

1% Risk Criterion

The 1% Risk criterion permits the loss the portion of the substation's peak load that is demanded for up to 1% of time in a year (87 hours per annum) following the outage of any component in the substation transformer circuit.

The 1% Risk criterion is applied to major regional zone substations.

Wester Power shall ensure that a suitable system spare transformer shall replace the failed transformer within a target period of 10 days.

In the meantime, the load shedding shall be restricted to:

- A maximum of one *feeder* at any one time on a rotational basis, and
- Any individual *feeder* may be subjected to shedding only once per day.

NCR Criterion

The NCR Risk criterion permits the loss of an amount of load equivalent to a transformer's pre-outage loading following the outage of any component in the substation transformer circuit.

The NCR Risk criterion is applied to zone substations in the Perth Metropolitan area.

Western Power shall ensure deployment of a rapid response spare transformer (RRST) to temporarily replace the failed transformer within the target period of 12 hours.

In the meantime, load shedding shall be restricted to:

- The required number of feeders to reduce the load below the remaining capacity of the substation by taking into consideration the available distribution transfer capacity, and
- Any individual *feeder* may be subjected to shedding only once until the RRST is installed

Following the deployment of the RRST, *Western Power* shall install a suitable spare transformer or procure a new transformer to permanently replace the failed transformer and release the RRST to cater for future contingencies.

2.5.1.5 N-1 Criterion

The remainder of the *transmission network* shall be designed to the N-1 criterion.

A section of a *network* designed to the N-1 criterion means that an *outage* of one of the N components that make up the *transmission sub-network* should allow *supply* to be maintained to that area without loss of *load* at any load level and for any generation schedule.

The N-1 contingency criterion applies to:

- All aspects of the steady-state criteria in clause 2.6.
- All aspects of the stability criteria in clause 2.3
- All aspects of the *power quality* criteria in clause 2.2.

For zone substation power transformers, supplying a total load greater than or equal to 20 MVA, no load shall be shed for the loss of one transformer, except as discussed in the next sentence. A short supply interruption, following the loss of any one power transformer, is permitted for a brief switching period to transfer the load to unfaulted transformers via distribution network switching. Spare capacity for this purpose shall be maintained.

2.5.2 Distribution Networks

Most distribution networks are designed and operated to the (N-0) criterion.

Western Power designs it's distribution networks as radial systems and in normal circumstances the loss of a component of the network will result in the loss of supply to a number of users. The extent of the loss of supply is minimised by the use of reclosers and sectionalisers and the speed of fault location is improved through the use of fault indicators.

In the Perth central business district an open meshed, remotely switched, high voltage distribution network is used to ensure rapid restoration of supply to unfaulted sections of the network. In addition, the zone substations have automatic feeder reconfiguration to cover the loss of a step down transformer and the total loss of a single zone substation can be covered by manual network reconfiguration.

In urban areas the density of users often results in an open, meshed network that is run radially with open points. This operating mode minimises fault levels and simplifies technical and operational requirements. In these situations improved supply restoration times are possible, although the initial loss of supply will still occur.

In rural areas the distribution network is, generally, radial and interconnections to reduce supply restoration times are often not possible.

Users requiring additional security of supply above the standard design philosophy will be accommodated where possible, although, in some circumstances, on-site standby generation may be the only practical alternative.
The distribution network is not designed for the islanded operation of generators and no Western Power distribution equipment is fitted with synchronizing equipment. Generators must disconnect from the network if the distribution feeder that they are connected to is separated from the remainder of the power system.

In summary and in contrast to transmission networks, distribution networks are generally radially operated. Following the fault clearance and isolation of the faulty component the supply is restored to customers. The time to restore supply largely depends on the location of the fault, and a general rule is that the restoration time decreases as the amount of load interrupted increases.

Contingency criteria for the distribution network therefore relates to the ability of the distribution network to be reconfigured after a fault so that the unfaulted portions of the network are restored. This is explained in more detail in the following sections.

2.5.2.1 Perth Central Business District High Voltage Distribution Feeders

The central business district (CBD) presents an important and sensitive load. Security and reliability of power supplies affect a large number of businesses, buildings and individuals. Therefore the planning criteria specific to the CBD are more "demanding" than for other areas of distribution networks.

The Perth CBD Zone is defined in the Access Arrangement Document.

The criteria adopted are that:

- Supply may be lost but remotely controlled network restoration will restore supply to the unfaulted portions of the network.
- For the loss of a zone substation, the total load of that zone substation shall be capable of being supplied from the adjacent zone substations via the distribution network.

2.5.2.2 Urban High Voltage Distribution Feeders

Existing distribution networks

- Any existing distribution networks shall be operated so that, for a zone substation feeder circuit or exit cable fault, the load of that feeder can be picked up by no more than four other feeders by manual reconfiguration. However, the overhead portions of a distribution network do not have any contingency criteria applied.

New distribution feeders

- Whenever practical, any new feeder shall be designed so that, at the end of the zone substation exit cable, the feeder is split into two radial spurs.
- Any new distribution feeder shall be designed so that, for a zone substation feeder circuit or exit cable fault, any other feeder does not pick up more than 50% of the feeder load from that which is out of service. The feeder(s) picking up the load can be from another zone substation.
- Any new underground distribution feeder, or portion of an underground feeder that has an installed transformer capacity of 1 MVA or more, shall be designed so that, as soon as adjacent developments permit, there is an alternative source of supply that is normally open, but can be closed to provide supply if a fault occurs on the normal supply.

2.5.2.3 Rural High Voltage Distribution Feeders

The radial nature of rural distribution feeders normally precludes the application of contingency criteria to these feeders. However, where technically and commercially feasible interconnection between feeders shall be provided.

2.5.2.4 Limits on Radial High Voltage Feeders

All radial High Voltage feeders (6, 11, 22 & 33 kV) shall limit the number of domestic customers to a maximum of 860 or to a load of no more than 2 MVA, which ever is least. Above these limits the circuit shall be inter connected to another part of the high voltage network.

2.5.2.5 Low Voltage Distribution Networks

Low voltage distribution networks are radial and interconnection is not a primary design criterion. However, where technically and commercially feasible, interconnection between low voltage feeders shall be provided.

For residential subdivisions all low voltage (415V) circuits shall have a switching point every 16 customers.

2.5.2.6 Pole to Pilar Connections Mandatory

All new connections and upgrades to existing overhead services to all customers will be underground. The overhead service will be converted to underground consumer mains.

2.5.2.7 Distribution Remote Control and Monitoring

All new or replaced transformers and switches (RMUS) shall be remotely operable and controlled from the control centre. On the transformers, remote operation will be on all the LV circuits, i.e. transformer LV and each LV feeder circuit.

All new and replaced transformers and switches shall be remotely monitorable from the control centre.

2.6 STEADY STATE CRITERIA

The steady state criteria define the adequacy of the transmission and distribution network to supply the energy requirements of Users within the component ratings and frequency and voltage limits, taking account of planned and unplanned outages.

The steady state criteria apply to the normal continuous behaviour of the transmission and distribution network and also cover post disturbance behaviour once the network has settled.

Each of the steady state criteria should be satisfied for the contingency criteria in clause 2.5 of these *Rules*-(N-1 and N-2 criteria where applicable).

2.6.0 Steady State Frequency Limits

The steady state *power system frequency* should not exceed the design limits specified in clause 2.2.1, Table 2.1, of these *Rules*. For SWIS, these values are:

- Under normal operating conditions the network frequency shall be maintained at 50Hz ±0.2 Hz.
- Under emergency conditions the network frequency may vary between 47 – 52 Hz, until the under frequency load shedding and other protection and control schemes restore balance between generation and consumption.

2.6.1 Steady State Voltage Limits

The steady state *power system voltage* should not exceed the design limits specified in clause 2.2.2 of these *Rules*.

Step changes in *voltage* should not exceed the limits specified in Table 2.10.

Table 2.10
Step - Change Voltage Limits

Cause ~~of~~ ~~Outage~~	Pre-Tap Changing		Post-Tap Changing (final steady state volts)	
	≥66kV	<66kV	≥66kV	<66kV
Routine Switching*)	±3.7% (max)	±3.7% (max)	Transmission voltages should be between 110% and 90% of nominal voltage	Should attain previous set point
Infrequent Switching or Events**)	+6%, -10% (max)	+6%, -10% (max)	Transmission voltages should be between 110% and 90% of nominal voltage	Should attain previous set point

*) for example, capacitor switching, transformer tap action, motor starting

**) for example, tripping of generators, loads, lines and other components, typically as a result of faults

Low Voltage
The low voltage steady state voltage must be within:
· ± 6% of the nominal voltage during normal conditions
· ± 8% of the nominal voltage during maintenance conditions
· ± 10% of the nominal voltage during emergency conditions

2.6.2 Thermal limits:

The thermal ratings of the *transmission and distribution network* components should not be exceeded under normal or emergency operating conditions when calculated on the following basis:

1) *Transformers*: Normal cyclic rating as defined by IEC 354.
2) Switchgear: Normal manufacturer's name plate rating.
3) Lines: Summer or winter continuous ratings appropriate for the season based on:
   a) ambient temperature being that for 1% probability of daily maximum temperature not being exceeded over the summer season (December to February), and 25°C for winter;
   b) wind speed being 1.0m/s;
   c) solar radiation being 1000W/m^2 (weathered surface); and
   d) conductor design clearance temperature as defined in ESAA Code C(b)1.
4) Cables: Normal cyclic rating, calculated using the Neher McGrath methodology, with maximum operating temperatures of 90 degrees for XLPE cables; 70 degrees for 11kV paper insulated cables, and 65 degrees for 11kV

paper insulated belted cable, and 22 kV and 33 kV paper insulated cables.

During an emergency, for a period of up to 12 hours, the maximum operating temperature for paper insulated cables shall be raised to 80 degrees C, and for XLPE insulated cables 120 degrees.

2.6.3 Fault limits

The calculated fault levels in the *transmission networks* shall not exceed 95% of the equipment fault rating.

For safety reasons, the fault level throughout the distribution network must not exceed the fault rating of any equipment in that part of the network at any time for any normal network configuration.

The *User* that causes changes to *distribution network* fault levels will be responsible for any *plant* upgrades required as a result of the changed *power system* conditions.

Criteria

The fault levels are limited to the following values throughout all Western Power's distribution networks:

- 6.6 kV networks 21.9 kA
- 11 kV networks 18.4 kA
- 22 kV networks 13.1 kA
- 33 kV networks 13.1 kA

Equipment connected to the distribution network must be designed to withstand these fault levels for 1 second.

2.6.4 Real and Reactive Generating Limits

In planning a network it is necessary to assess the reactive power requirements under light and heavy load conditions to ensure that the reactive demand placed on the generators, to absorb or generate reactive power, does not exceed the capability of the generators.

Similarly, network frequency will fall if there is insufficient total generation to meet demand. Although the reduction in frequency will cause a reduction in power demand, it is unlikely that this will restore the balance, therefore sufficient amount of load must be disconnected to enable the frequency to rise to an acceptable level, as is explained in clause 2.4 of these *Rules*.

Limits to the active generation and reactive (VAr) generation and absorption capability of generating and reactive compensation plant such as *static VAr compensators* are not to be exceeded.

2.6.5 Transmission Reactive Planning Process

Reactive capacity is obtained from a combination of static and dynamic sources. Static sources include, for example, reactors and capacitor banks. Dynamic sources include, for example, synchronous machines, operating as generators or synchronous compensators, and static VAr compensators.

All necessary steps should be taken to ensure that *voltage* collapse does not occur for the most onerous outage of any power system element under credible *generation* schedules under all *load* conditions. It should be assumed that 3% of all installed LV *capacitor banks* in addition to one *capacitor bank* or reactive device that has the largest impact in the system are unavailable. Adequate *reactive power reserves* based on *power system* studies should be provided.

1) For terminal substations in the metropolitan area the following procedure is used at present:
   a) The disturbance, which takes the system closest to voltage collapse, is determined by investigating likely worst case scenarios.
   b) 3% of the total installed LV *capacitor banks* plus the largest HV *capacitor bank* on the system are to be taken out of service.
2) For other areas of the system, including radials, the following procedure is used to determine the *voltage* stability or transfer limit:
   (a) The normal peak system *generation* pattern that provides the lowest level of *voltage* support to the area of interest is assumed. (Of these *generators*, normally in service in the area, the largest generator is assumed to be out-of-service due to a breakdown or other maintenance requirements. If another generator is assigned as a backup unit then it may be brought into service to support the load area.
   (b) The largest *capacitor bank,* or the one that has the largest impact, in the area is to be taken as out-of-service where the area involves more than one substation.
   (c) The tripping of a line or other plant or tripping of a *generator* that causes the largest reduction in system *voltage* support in the area of interest is taken as the disturbance used to establish the transfer limit or *reactive support* limit.
3) In all situations the following procedures are to be followed:
   a) All loads are modelled as constant P & Q *loads*.
   b) The *load* to be used in the study is to be taken as 5% higher than the expected system *peak load,* or a 5% higher *transfer* into the area. (The 5% margin includes a safety margin for hot weather, data uncertainty and uncertainty in the simulation.)
   c) A positive MVAr reserve margin is to be maintained at major load points for this 5% higher load. (System *voltages* should remain within the normal operating range).
   d) All credible *generation* schedules are to be considered with none of the steady state MVAr limits to be reached or exceeded.
   e) System conditions are checked after the *outage* but prior to tap changing of transformers.

2.7 SAFETY CRITERIA

As part of the planning process the safety risk should be considered for any new developments and existing *facilities* which may have a significant impact on safety. The safety risk is to be assessed in the planning process. Relevant bodies should be informed, consulted and steps taken to ensure safety is maintained to industry standards and statutory requirements, including but not limited to those of WA Electricity Regulations 2001.

2.8 ENVIRONMENTAL CRITERIA

Western Power Corporation's environmental policy states

- "Western Power will be recognised as a leader in environmental management by demonstrating responsible stewardship of its operations in the environment".
- Western Power will minimise adverse environmental effects while providing for the efficient and reliable generation, transmission and distribution of electricity.

Western Power commits to the following objectives to fulfil its environmental policy:

- To consult openly and fully with the community and government where Corporation activity may affect the environment.
- To ensure that planning and design for new projects and changes to existing processes provide for consideration of best environmental practice technology and timely impact assessment.
- To carry out business in a resource efficient manner.

Western Power planning, construction and operation works embody environmental management principles including consultation, proactive planning, compliance, sustainable development and auditing for continuous improvement.

2.8.1 Enviromental Legislation

The *Environmental Protection Act (1986)* is the principle legislative framework for environmental protection in Western Australia.

Under the provisions of the Act, any new project or change to an existing installation, which may have a significant impact on the environment, must be referred to the Environmental Protection Authority (EPA) for assessment and approval.

In addition to the Environmental Protection Act (1986) other environmental legislation is applicable to Western Power's activities and will be complied with. These include (but are not limited to): Environmental Protection & Biodiversity Action (1999), Aboriginal Heritage Act (1972), Conservation & Land Management Act (1984), Contaminated Sites Act (2003), Dangerous Goods Safety Act (2004), Wildlife Conservation Act (1950).

Western Power's distribution networks will be developed so that these commitments are met.

2.8.2 Social Issues

Western Power will proactively inform and consult with government agencies, interested community groups and members of the community when planning new developments and facilities.

2.8.3 Electromagnetic Fields

Recognising the current state of scientific uncertainty regarding adverse health effects from exposure to power frequency electric and magnetic fields, Western Power shall act prudently and design, construct and operate all equipment and facilities to maintain electromagnetic frequency exposure to the public and Western Power employees at levels within industry standards.

2.8.4 Land-use Considerations

Western Power will avoid working within natural, cultural and historical sites. If unable to avoid working within these sites, Western Power will seek the necessary approvals from relevant Decision Making Authorities for planned activities or retrospective approvals for unplanned activities to ensure activities are consistent with the safe and reliable operation of the electricity supply network.

2.8.5 Noise

Western Power and *Users* shall plan, design, construct, augment or replace and operate works to comply with the noise levels established by the Environmental Protection (Noise) Regulations 1997. This may include building suitable noise enclosures to mitigate equipment noise.

2.8.6 Visual Amenity

Given that the community and customers are sensitive to the visual impact of electrical installations, Western Power shall conduct its electricity supply operations in a manner that minimises visual impact.

2.9 AUTOMATIC RECLOSURE OF TRANSMISSION OR DISTRIBUTION LINES

Where *automatic reclose equipment* is provided on *transmission lines* or *distribution lines*, check or blocking *facilities* must be applied to the *automatic reclose equipment* in those circumstances where there is any possibility of the two ends of the *transmission line* or *distribution lines* being *energised* from sources that are not in *synchronism*.

2.10 DISTRIBUTION DESIGN STANDARD CRITERIA

All residential subdivision networks will be designed to supply the 50 year maximum load anticipated for that area.

All Commercial and Industrial subdivisions networks will be designed to supply the 50-year maximum load anticipated for that area.

2.11 DISTRIBUTION CONSTRUCTION STANDARDS CRITERIA

Western Power shall construct the overhead portions of it's distribution networks in accordance with the Electricity Supply Association of Australia publication C (b) 1 - "Guidelines for Design and Maintenance of Overhead Distribution and Transmission Lines" and install the underground portions of it's distribution networks in accordance with the Electricity Supply Association of Australia publication C (b) 2 - "Guide to the Installation of Cables Underground".

Other statutory requirements include, but are not limited to, WA Electricity Distribution Regulations; the Guidelines for Electricity Transmission and Distribution work in Western Australia, current edition is 12/98, issued by Energy Safety (former Office of Energy); ESAA Guide to the use of separate connectors D (b) 30 – 1983; AS/NZS 2832.1:1998 "Cathodic protection of metals, pipes and cables"; AS/NZS 2648.1 – 1995 "Underground marking tape – Non detectable tape", etc.

2.12 DISTRIBUTION CARRIER SELECTION CRITERIA

The Western Australian government is committed to the undergrounding of power to half of the distribution network in Perth and Regional Centres by 2010. In accordance with this objective, Western Power shall use underground cables for network reinforcement and extension within the Perth Metropolitan area and Regional Centres, where in Western Power's opinion they are appropriate. Outside of these areas Western Power will install underground cables where technical and commercial considerations permit.

In designing extensions to the distribution network, ultimate load horizon planning shall be used to establish the network concept plan and the initial installation shall conform to that concept plan and use carriers that are appropriately sized. This methodology eliminates the need to disrupt the community in future years as load growth occurs and results in the minimum life time cost to the community.

To achieve maximum cost efficiency in the installation of carriers, standard conductor and cable sizes have been selected. This results in minimum stock holdings and purchase prices, giving the Users the least cost distribution network:

- The standard carrier size that is equal to, or greater than that required for the reasonably foreseeable load, shall be used for each overhead network extension or reinforcement.
- The standard carrier size that is equal to, or greater than that required for the horizon load, shall be used for each underground network extension or reinforcement.

3. TECHNICAL REQUIREMENTS OF *USER FACILITIES*

3.1 INTRODUCTION

This Section sets out details of the technical requirements which *Users* must satisfy as a condition of *connection* of any *plant* and equipment to the *power system* (including *embedded generators*), except where specifically varied in an *access contract*. It provides the specific requirements for both generators and load users, together with details of the protection requirements necessary to ensure stable network operation.

All users, generators and loads, must be able to de-energise their own plant, equipment or substation without reliance on Western Power.

3.2 REQUIREMENTS FOR *CONNECTION* OF *GENERATORS*

For generating plant the combined output of which is less than 10 MW and which are connected to distribution network below 66kV the connection requirements of Section 3.5 shall apply.

NOTE: The 10 MW threshold is chosen to coincide with the cut-off size for the WA wholesale market. The wholesale market participation is compulsory for the generation plant rated 10 MW and above.

Western Power will carry out detailed *power system* studies to determine performance requirements to be expected from a proposed new *generating unit* or modification to an existing *generating unit*.

Users will be responsible for ensuring that *plant* capabilities and ratings are monitored on an ongoing basis to ensure continued suitability as conditions on the *power system* change in the future (e.g. increasing fault levels as additional *plant* is *connected* to the *power system*). A

If, after installation of a *User's facilities*, it is found that the installation is adversely affecting the security or reliability of the *power system*, the *quality of supply*, or the installation does not comply with the *Code* or the relevant *access contract*, the *User* shall be responsible for remedying the problem.

Unless otherwise specified, technical requirements for non-synchronous generators will apply at the connection point, rather than at the generator terminals, to allow flexibility in design.

A generating unit must have plant characteristics and control systems, including but not limited to the inertia (effective, presented to the power system), short-circuit ratio and power system stabilisers, sufficient to:

(1) not cause any reduction of inter-regional or intra-regional power transfer capability because of:

   (i) rotor angle stability,

(ii) frequency stability, or

(iii) voltage stability

by more than its loading level whenever it is synchronysed / connected relative to the level that would apply if the generating unit were disconnected;

(2) not cause instability that would adversely impact other Users.

Users and Western Power shall not be adversely affected by transients caused by relatively large non-synchronous generators.

A non-synchronous generator should not cause reduction of inter-regional or intra-regional power transfer capability by more than its loading level whenever it is connected relative to the level that would apply if the non-synchronous generator was disconnected.

Trip of the unit should not cause increased need for load shedding because of:

(i) Rate-of-change-of frequency

(ii) Magnitude of frequency excursion

(iii) Active power imbalance

(iv) Reactive power imbalance

(v) Displacement of reactive capability

above the level that would apply if the generating unit were disconnected.

3.2.1 Technical Characteristics

a) A *User* must ensure that its *synchronous generating unit(s)* comply with the requirements advised by *Western Power* as to the minimum subtransient reactance of the *generating unit(s)* to control fault levels on the *transmission* and *distribution network* and/or *distribution network*.

A *User* must ensure that its *generating unit(s)* other than synchronous generating unit(s) complies with the requirements advised by *Western Power* as to the minimum / maximum fault current contribution of the *generating unit(s)* to control fault levels on the *transmission network* and/or *distribution network.*

If connection/disconnection of the *User* causes excessively high or low fault levels then this issue needs to be addressed by other action.

b) The requirements to ensure stability of the *electricity transmission network* and maintain *power transfer capabilities* may have an impact on the generator, step-up transformer, turbine, inertia constant, turbine control or excitation system, etc, of the synchronous/induction *generating unit* or the control system characteristics/behaviour for an inverter or converter coupled generating unit.

c) All generating units, synchronous or otherwise, must provide voltage control within own reactive power capability of clause 3.2.4.1, as per the applicable control strategy, limits and range set out in clause 3.2.5.4. For non-synchronous generating units, when synchronised, the maximum permissible settling times of Table 3.1 shall apply (the last two rows).

3.2.2 Technical Matters to be Co-ordinated

The *User* and *Western Power* must use all reasonable endeavours to agree upon the following matters in respect of each new or altered *connection*:

a) Design at *connection point*;
b) Physical layout adjacent to *connection point*;
c) *Protection* and backup;
d) Control characteristics;
e) Communications, *metered* quantities and alarms;
f) Insulation co-ordination and lightning protection;
g) Fault levels and fault clearing times;
h) Switching and *isolation facilities*;
i) Interlocking arrangements;
j) *Metering installations* as described in Section 6;
k) *Synchronising facilities*;
l) *Under frequency load shedding* and islanding schemes; and
m) Any special test requirements.

Prior to *connection* to the *Western Power power system*, the *User* shall have provided to *Western Power* a signed written statement to certify that the equipment to be *connected* has been designed and installed in accordance with this *Code*, all relevant standards, all statutory requirements and *good electricity industry practice*. The statement shall have been certified by a Chartered Professional Engineer with NPER standing with the Institution of Engineers, Australia, unless otherwise agreed.

3.2.3 Provision of Information

The *User* must provide all data reasonably required by *Western Power*.
Details of the kinds of data that may be required are included in Attachments 3 and 4 of this *Code*.

3.2.4 Detailed Technical Requirements Requiring Ongoing Verification

The technical requirements described in this section are required to be demonstrated by the methods described in clause 4.1.3 of this *Code.*

3.2.4.1 *Reactive power* capability

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

(a) Unless otherwise agreed by *Western Power*:

(1) Each *synchronous generating unit* must be capable of *supplying* a *reactive power* output coincident with rated real power output such that at the *generating unit's* terminals at nominal *voltage* the lagging *power factor* is less than or equal to 0.8 and at the same power output the *generating unit* must be capable of absorbing *reactive power* at a leading *power factor* less than or equal to 0.9. Refer to Figure 3.1 for details.

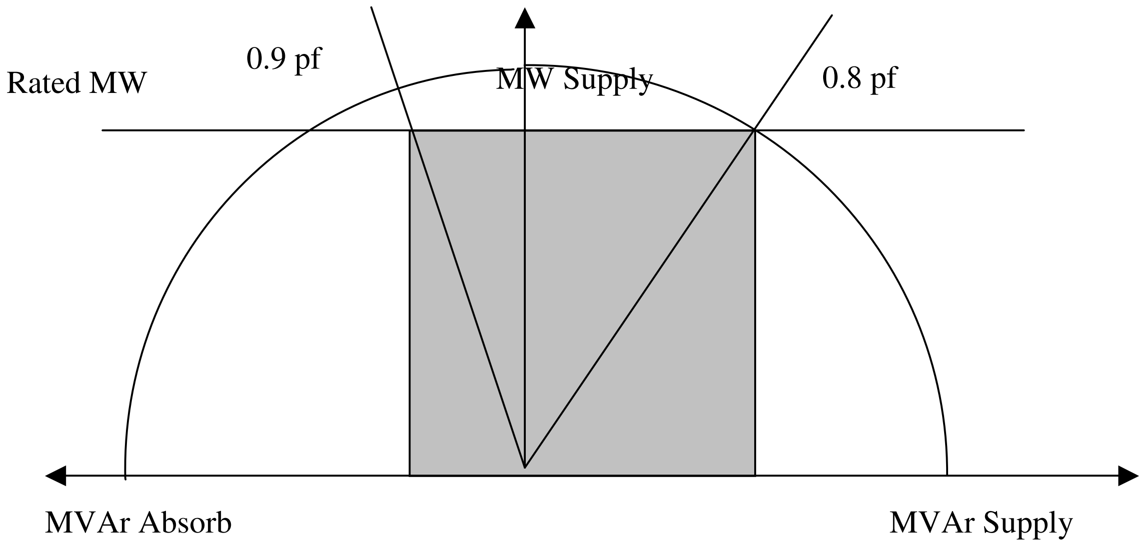

Figure 3.1 Synchronous Generating Unit Reactive Power Capability Requirements at Generator Terminals shown Shaded

(2) Each *induction generating unit* must be capable of *supplying a reactive power* output coincident with rated real power output such that at the *connection point* to the *network* at *nominal voltage* the lagging *power factor* is less than or equal to 0.95 and at the same power output the *generating unit* must be capable of absorbing *reactive power* at a leading *power factor* less than or equal to 0.95.

In some circumstances, a larger *power factor* range may be required. This will be determined by *power system* simulation studies. *Users* will be advised accordingly of any additional requirements. Refer to Figure 3.2 for details.

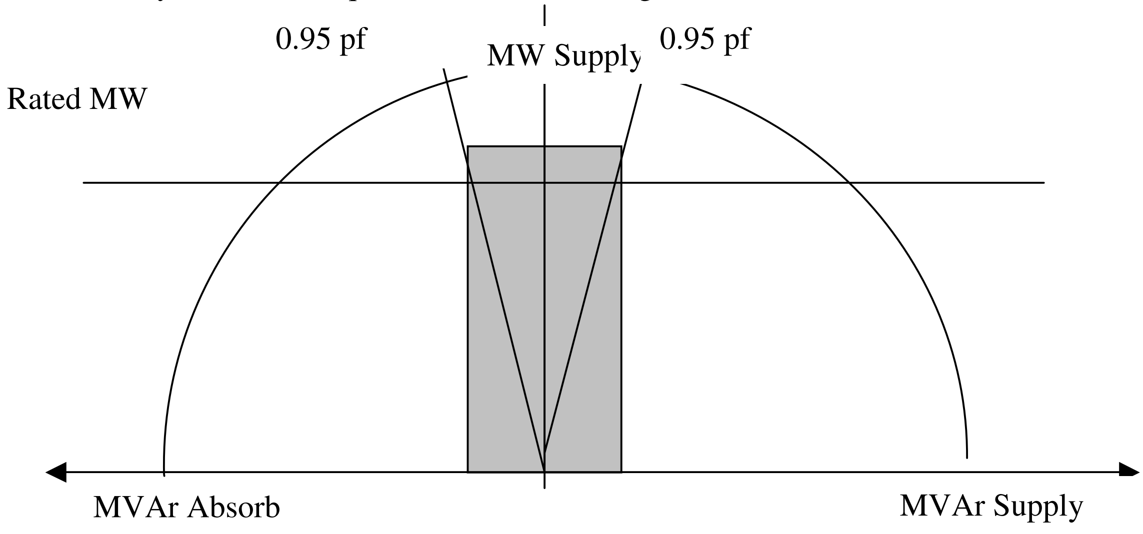

Figure 3.2 Induction Generating Unit Reactive Capability Requirements at Point of Common Coupling shown Shaded

(3) Each *inverter or converter coupled generating unit* shall be capable of supplying a reactive power such that at the inverter or converter connection point to the network at nominal voltage the lagging power factor is less than or equal to 0.95 and shall be capable of absorbing reactive power at a leading power factor less than or equal to 0.95.

In some circumstances, a larger *power factor* range may be required. This will be determined by *power system* simulation studies. *Users* will be advised accordingly of any additional requirements. Refer to Figure 3.3 for details.

(4) For generators for not described by susbsections (1), (2) or (3), the power factor requirements shall be as advised by Western Power.

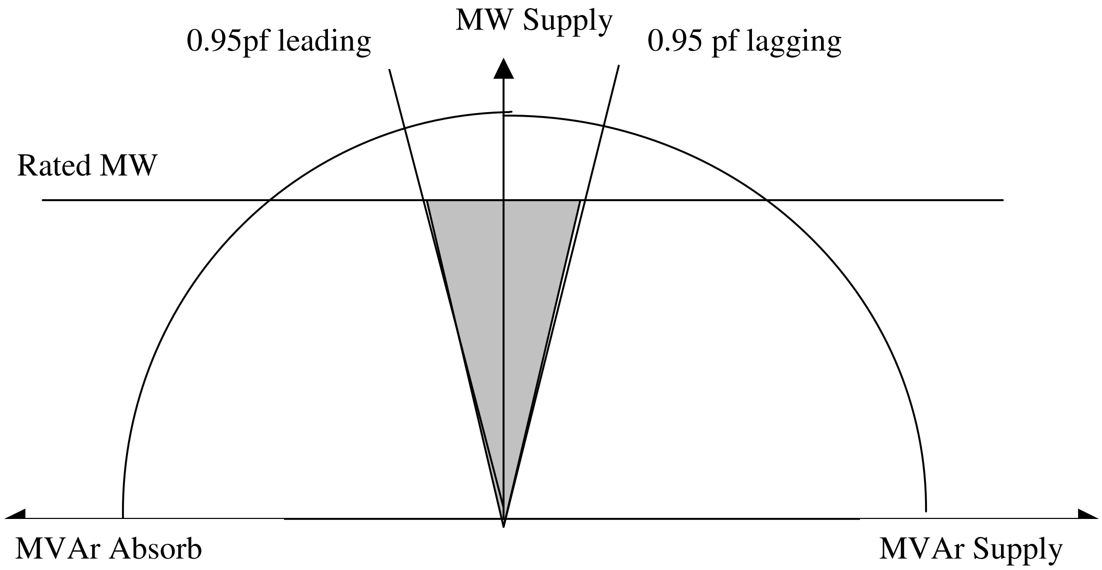

Figure 3.3 Inverter Coupled or Converter Coupled Generating Unit Reactive Capability Requirements at Point of Common Coupling shown Shaded

(b) In the event that the *power factor* capabilities specified in (a)(1), (a)(2) and (a)(3), as applicable, cannot be provided, the *User* must reach a commercial arrangement under the *access contract* with *Western Power* for the *supply* of the deficit in *reactive power* as measured at the *generating unit's* terminals.

(c) The *Generator connection* must be designed to permit the *dispatch* of the full *active power* and *reactive power capability* of the installation as specified in the *access contract* under all *power system* conditions contained in Section 2 of this *Code*.

3.2.4.2 Quality of Electricity Generated

When operating *unsynchronised,* a *synchronous generating unit* must *generate* a constant *voltage* level with balanced phase *voltage*s 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 relevant international standard, as agreed between *Western Power* and the *User*.

For generating units other than synchronous generating units the contributions to *quality of supply* must be not less than that required to be provided by *Users* as defined in Clause 2.2.

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

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. The *continuous uninterrupted operation* is defined at the end of this clause. *Network* performance requirements are detailed in Section 2 of this *Code*.

a) **Immunity to frequency excursions.** Users must ensure that within the power system frequency range and duration of Figure 3.4 all of their power system equipment will remain in service unless that equipment is required to be switched to give effect to load shedding in accordance with clause 2.4, or is required by *Western Power* to be switched for operational purposes (Note: this sentence moved from clause 2.2.1). In particular, a *generating unit*, and the *power station* in which the *generating unit* is located, must be capable of continuous uninterrupted operation within the *power system frequency range* 47.5 to 52 Hz.

The minimum duration of operation at *frequencies* outside the range 47.5 to 52 Hz for the *South West Interconnected System* shall be in accordance with 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.

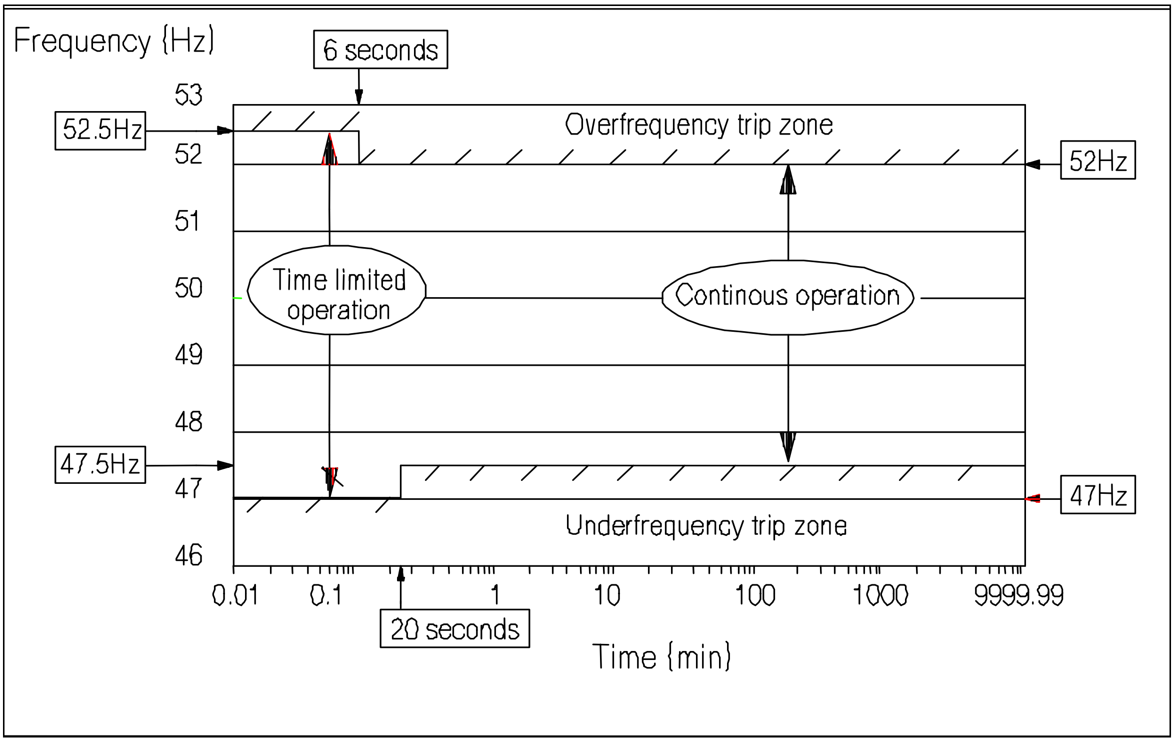

Figure 3.4 – Off Nominal Frequency Operation Capability Requirement for Generators

Sustained operation outside the range 47.5 to 52 Hz need not be taken into account by *Western Power* and *Users* in the design of *connected plant* which may be *disconnected* if this is necessary for the *protection* of that *plant*. Below 47Hz, and above 52.5 Hz instantaneous tripping of *generators* is permitted.

b) **Immunity to voltage excursions.** A *generating unit*, and the *power station* in which the *generating unit* is located, must be capable of continuous uninterrupted operation for the range of *voltage* variation permitted by Clause 2.2.2 and Clause 2.3.3.2, and for *transmission or distribution network* faults which cause the *voltage* at the *connection point* to drop to between 0% and 80% of nominal voltage for a period of up to 450 milli second (based on 330kV CB fail protection time) in any one phase or combination of phases, followed by a period of ten seconds where *voltage* may vary in the range 80-110% of the nominal *voltag*e, and a subsequent return of the *voltage* within the range 90-110% of the nominal *voltag*e. See Figure 3.5 for details of the latter.

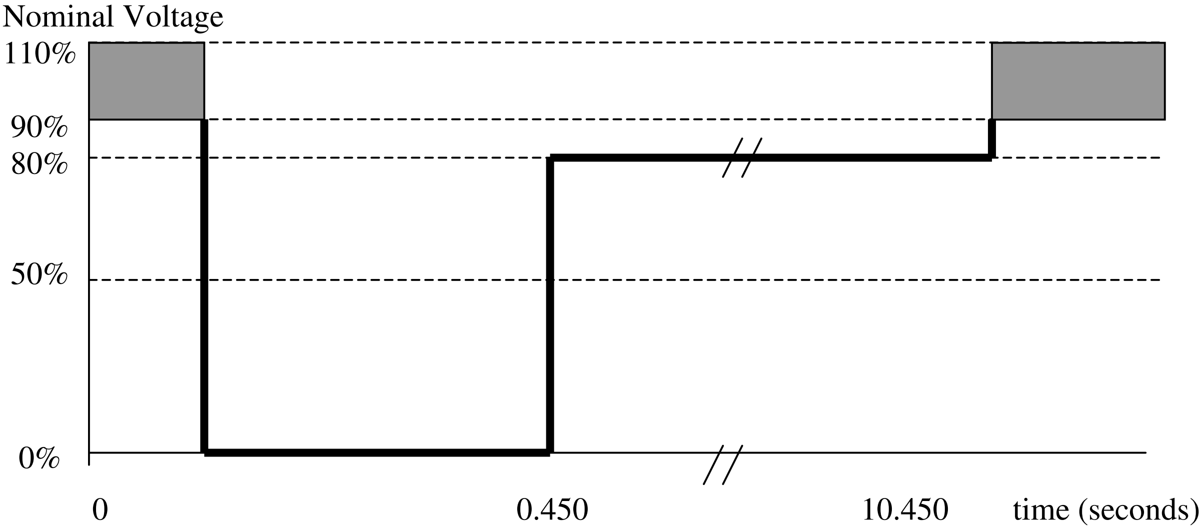

Figure 3.5 – Off Nominal Voltage Operation Capability Requirement for Generators that complement those of Figure 2.1

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

d) **Immunity to high speed auto reclosing.** A *generating uni*t, and the *power station* in which the *generating unit* is located, must be capable of continuous uninterrupted operation for transients caused by high speed auto reclosing of transmission lines.

e) **Post-fault reactive power of a power station with non-synchronous generators.** After fault clearing, the *power station* in which a non-synchronous *generating unit* is located shall not absorb reactive power from the grid, and the absorption, if any, of inductive reactive power has to be terminated within 200ms after clearing of the fault.

Continuous uninterrupted operation.

For the purpose of this clause 3.2.4.3 *continuous uninterrupted operation* shall mean other than disconnection due to protection operation. Protection operation shall not limit the capability of the generating unit in meeting the requirements of this clause.

The MW output shall return to pre-fault MW output, allowing for system voltage variation below 90% of nominal, within 200ms after the voltage has returned to between 80-110% of nominal voltage. The variation in MW output for non-dispatchable generators shall also be allowed for.

Synchronous generating units - the MVAr output shall be determined by clause 3.2.5.4.

Generating units, other than synchronous generating units, - the MVAr output shall return to the pre-fault MVAr within 200ms after the voltage has returned to between 80-110% of nominal voltage.

3.2.4.4 Partial L*oad* Rejection

A *generating unit* must be capable of continuous uninterrupted operation, during and following a *load* reduction which occurs in less than 10 seconds, from a fully or partially *load*ed condition provided that the *load* reduction is less than 30% of the *generating unit's nameplate rating* and the *load* remains above minimum load or as otherwise agreed between *Western Power* and the relevant *User* and stated in the *access contract* between them.

3.2.4.5 *Load*ing Rates

A *scheduled generating unit* must be capable of increasing or decreasing *load* in response to a manually or remotely initiated *loading* order at a rate not less than 5% of *nameplate rating* per minute or as otherwise agreed between *Western Power* and the relevant *User,* stated in their *access contract*.

A Non-Dispatchable generating unit, must not increase or decrease its loading at a rate greater than 15% of nameplate rating per minute or as otherwise agreed between *Western Power* and the relevant *User,* stated in their access contract.

3.2.4.6 Safe Shutdown without External Electricity *Supply*

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

3.2.4.7 Restart Following Restoration Of External Electricity *Supply*

A *generating unit* must be capable of being restarted and *synchronised* to the *power system* without unreasonable delay following restoration of external *supply* from the *network power system* at the relevant *connection point*, after being without external *supply* for two hours or less, provided that the *generating unit* was *disconnected* for any reason other than a fault within the *generating unit*.

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

(a) delays not inherent in the design of the relevant start-up *facilities* and which could reasonably have been eliminated by the relevant *User*; and
(b) 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 two hours or less.

3.2.4.8 Protection of Generating Units From Power System Disturbances

(a) A *generating unit* must be automatically *disconnected* from the *power system* in response to conditions at the relevant *connection point* which are not within the agreed engineering limits for operating the *generating unit* or where the conditions may impact on other *Users*. These abnormal conditions will include and are not necessarily limited to:

(1) loss of *synchronism* (Out-of-step *protection*/pole-slip *protection* may need to be located on the *transmission network*; this should be determined by performing *power system* simulation studies);

(2) sustained high or low *frequency* outside the *power system frequency* range 47.5Hz to 52Hz - refer to clause 2.2.1;

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

(4) excessive high or low stator *voltage*;

(5) excessive *voltage* to *frequency* ratio;

(6) excessive negative phase sequence current;

(7) loss of excitation;

(8) reverse power, and

(9) isolated operation of non-scheduled generation types and generation connected to distribution network to avoid uncontrolled supply of local loads.

(10) Any similar condition agreed between the *Generator* and *Western Power*.

(b) The actual settings of the *protection* equipment installed on a *generating unit* determined by the *User* to satisfy requirement (a) must be consistent with *power system* performance requirements specified in Section 2 and must be approved by *Western Power* in respect of their potential to reduce *power system security*. They must be such as to maximise *plant* availability, to assist the control of the *power system* under emergency conditions and to minimise the risk of inadvertent *disconnection* consistent with the requirements of *plant* safety and durability.

Western Power shall bear no responsibility for any loss or damage incurred by the *User* as a result of a fault on either the *power system*, the *User's facility* or within the *generating unit* itself.

3.2.4.9 User Protection Systems That Impact On Power System Security

Refer to Clause 3.4 for the requirements of *protection systems* for *Users' plant*. The requirements of Clause 3.4 apply only to *protection* which is necessary to maintain *power system security*. *Protection* solely for *User* risks is at the *User's* discretion.

3.2.4.10 Generator T*ransformer*

Generator transformer are generally needed to ensure compliance with the requirement that each generating unit, and the power station in which the generating unit is located, must be capable of continuously providing its full reactive power output within the full range of steady state voltages at the *connection point* permitted under clause 2.2.2.

Vector Group. The transformer type shall be agreed with *Western Power* with preference given to transformers with a zero sequence opening between high-voltage and low-voltage windings and a type that is consistent with *Western Power* practice.

Tapping. Unless otherwise agreed between *Western Power* and the *User*, the generator *transformer* of a *generating unit* or wind farm must be capable of on-*load* tap-changing within the range specified in the relevant *access contract* .

3.2.5 Monitoring and Control Requirements

3.2.5.1 Remote monitoring

Western Power will require the *User* to:

I. provide *remote monitoring equipment* ("*RME*") to enable *Western Power* to remotely monitor performance of a *generating unit* (including its *dynamic performance*) where this is reasonably necessary in real time for control, planning or security of the *power system*; and

II. upgrade, modify or replace any *RME* already installed in a *power station* provided that the existing *RME* is, in the reasonable opinion of *Western Power*, no longer fit for purpose and notice is given in writing to the relevant *User*.

In (I) and (II), the *RME* provided, upgraded, modified or replaced (as applicable) must conform to an acceptable standard as agreed by *Western Power* and must be compatible with *Western Power's SCADA system*, including the requirements of clause 5.12 of this *Code*.

Input Information to *RME* may include, but not be limited to, the following:

(a) Status Indications

(1) *generating unit* circuit breaker open/closed (dual point)
(2) remote *generation load* control on/off
(3) *generating unit* operating mode
(4) turbine control limiting operation
(5) *connection* to the *transmission* or *distribution network*

(b) Alarms

(1) *generating unit* circuit breaker / main switch tripped by *protection*
(2) prepare to off *load*
(3) *protection* defective alarms

(c) Measured Values

Transmission:
(1) Gross *active power* output of each *generating unit*
(2) Gross *reactive power* output of each *generating unit*

(3) Net station *active power* import or export at each *connection point*
(4) Net station *reactive power* import or export at each *connection point*
(5) *Generating unit* stator *voltage*
(6) *Generating unit transformer* tap position
(7) Net station output of *active energy* (impulse)
(8) *Generating unit* remote *generation* control high limit value
(9) *Generating unit* remote *generation* control low limit value
(10) *Generating unit* remote *generation* control rate limit value

Distribution:
(1) Main switch *active power* import or export
(2) Main switch *reactive power* import or export
(3) Voltage on Western Power side of main switch

(d) Such other input information reasonably required by *Western Power*.

A *User* must provide electricity supplies for the *RME* installed in relation to its *generating units* capable of keeping these *facilities* available for at least eight hours following total loss of *supply* at the *connection point* for the relevant *generating unit*.

3.2.5.2 Remote control

Western Power will require the *User* to:

I. Provide *remote control equipment* ("RCE") to enable *Western Power* to remotely control a generating unit circuit breaker, or other circuit breaker as detailed below; and

II. upgrade, modify or replace any *RCE* already installed in a *power station* provided that the existing *RCE* is, in the reasonable opinion of *Western Power*, no longer fit for purpose and notice is given in writing to the relevant *User*.

In (I) and (II), the *RCE* provided, upgraded, modified or replaced (as applicable) must conform to an acceptable standard as agreed by *Western Power* and must be compatible with *Western Power's SCADA system*, including the requirements of clause 5.12 of this *Code*.

Input Information to *RCE* may include, but not be limited to, the following:

(a) Control Facilities (typically for unmanned sites)

(1) Generating unit remote generation Stop Initiate
(2) Generating unit remote generation Start Initiate
(3) Generating unit remote generation Active Power setpoint
(4) Generating unit remote generation Reactive Power setpoint
(5) Generating unit remote generation Generator Step-Up transformer Tap Position

(b) Control Facilities (typically for distribution sites)

(1) An inter-trip for:

- A feeder fault causing a feeder circuit breaker operation at the relevant zone substation
- A trip command initiated by the control centre
- SCADA communication failure

(2) A close enable interlock

These controls shall apply to the following plant as applicable:

- Generating unit circuit breaker
- Any other circuit breaker in the path between the network and the generators,
- Installation main switch.

A *User* must provide electricity supplies for th *RCE* installed in relation to its *generating units* capable of keeping these *facilities* available for at least eight hours following total loss of *supply* at the *connection point* for the relevant *generating unit*.

3.2.5.2 Communications Equipment

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

Telecommunications between *Western Power* and *Generators* must be established in accordance with the requirements set down below for *operational communications*.

(a) Primary Speech Facility

Each *User* must provide and maintain equipment by means of which routine and emergency control telephone calls may be established between the *User's* responsible Engineer/Operator and *Western Power*.

The *facilities* to be provided, including the interface requirement between *Western Power's* equipment and the *User's* equipment must be specified by *Western Power*.

(b) Back-up Speech Facility

Where *Western Power* advises a *User* that a back-up speech *facility* to the primary *facility* is required, *Western Power* will provide and maintain a separate telephone link or radio installation

Western Power shall be responsible for radio system planning and for obtaining radio licenses for equipment used in relation to the *Western Power networks*.

3.2.5.3 Turbine Control System

All *generating units* must have an automatic variable speed control characteristic. Turbine control systems must include *facilities* for both speed and *load* control except where approved by *Western Power*.

Generating units must normally be operated in a mode–in which they will automatically accurately alter (every four seconds) with a change in *associated loads* plus allow for changes in *frequency* of the *network* according to the performance requirements detailed below and in a manner to sustain high initial response. For steam generating units, this mode is known as the coordinated boiler follow mode.

The *User* must notify *Western Power* prior to a *generating unit* being operated in a mode (e.g. "turbine-follow" mode) where the *generating unit* will be unable to respond as specified and agreed.

<u>*Deadband*</u>

> The dead band of a *generating unit* (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.

<u>*Control Range*</u>

For Dispatchable generating units

> 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 up to 5% for a 0.1 Hz reduction in *power system frequency* for any initial output up to 85% of rated output and a reduction in the *generating unit's active power* output of up to 5% for a 0.1 Hz increase in *system frequency* provided the latter does not require operation below technical minimum. For initial outputs above 85% of rated output, response capability must be included in the *access contract*, and the *User* must use reasonable endeavours to ensure that the *generating unit* responds in accordance with that contract. Thermal *generating units* must be able to sustain *load* changes of at least 10% for a *frequency* decrease and 20% for a *frequency* increase if changes occur within the above limits of output.

For Non-Dispatchable generating units

> Overall response of a *generating unit* for *power system frequency* excursions must be setable and be capable of achieving a reduction in the *generating unit's active power* output for an increase in *system frequency* provided the latter does not require operation below technical minimum.

> Non-dispatchable generating units with technologies which intrinsically allow the control of power output are required to be equipped with such controls to facilitate

frequency control. For example, wind turbines with pitch control can control electric power output relative to the maximum energy that can be extracted from the wind.

Rate of Response

The *frequency* response must be agreed between *Western Power* and the relevant *User* and stated in the *access contract* between them.

For Dispatchable generating units

For any *frequency* disturbance a *generating unit* must achieve at least 90% of the maximum response to power *generation* expected according to the droop characteristic within a time to be specified in the *access contract* and advised to *Western Powe*r. This time shall be typically six seconds for thermal *generating units* and the new output shall be sustained for 30 seconds. The time shall be typically 30 seconds for hydro *generating units* and the new output shall be sustained indefinitely.

For Non-Dispatchable generating units

For any *frequency* disturbance a *generating unit* must achieve at least 90% of the maximum response to power *generation* expected within a time to be specified in the *access contract* and advised to *Western Powe*r. The time shall be typically 2 seconds for wind and solar *generating units* and the new output shall be sustained indefinitely.

Connections to Distribution Netrwork

Upon the loss of supply from *Western Power*, each governing system shall cause it's generator frequency to drift at a minimum rate of 0.1 Hz per second per 1% difference between the real power output set point and the load connected to the generator.

3.2.5.4 Excitation Control System

Control strategy

Unless otherwise agreed by Western Power under an access contract:

(a) The overriding objective of the *generating unit* excitation control system is to maintain the nominated voltage range at the *connection*.
The normal operating mode shall be such that each *Generator User* shall provide sufficient reactive power injection into, or absorption from, the *Western Power* network to meet the requirements of its associated loads, plus all reactive losses required to deliver its real power output at network voltages within the ranges expected during normal operation and under contingency conditions. The size of each reactive "step" shall be such that the *quality of supply* limits is not breached.

When a generator connected to the distribution system is supplying power to *Western Power* for generation support the normal operating mode shall be such that each *generating unit* is set to maintain a constant power factor (± 0.05) which is equal to the power factor of the peak feeder load that the *power station* is normally connected to. If the total *power station* export capacity exceeds the feeder peak load, then the combined power factor of the applicable zone substation transformer peak load shall be used.

When it is not possible for *generating units* supplying power to *Western Power* for generation support to operate at constant power factor and simultaneously maintain the nominated voltage range, then the generating units shall automatically vary their power factor within the stability limits of the units.

If the stability limit of the *generating units* is reached, then in order to ensure that the nominated voltage range at the *connection* is maintained, the *power station* has the following options (which are not mutually exclusive):

- · Automatically reduce the real power export level appropriately.
- · Automatically switch reactive power compensation devices. The size of each reactive "step" shall be such that the *quality of supply* limits is not breached.

<u>Capabilities</u>

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

(a) limiting *generating unit* operation at all *load* levels to within *generating unit* capabilities for continuous operation;

(b) controlling *generating unit* excitation to maintain the short-time average *generating unit* stator *voltage* at highest rated level (which must be at least 5% above the nominal stator *voltage* and is usually 10% above the nominal stator *voltage*). The upper voltage limits must be compatible with transformer selection of clause 3.2.4.10;

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

(d) providing five second ceiling excitation *voltage* at least twice the excitation *voltage* required to achieve maximum continuous rating at nominal *voltage*; and

(e) providing reactive current compensation settable for boost or droop unless otherwise agreed by *Western Power*.

New synchronous *generating units* must be fitted with fast acting *excitation control systems* utilising modern technology. AC exciter, rotating rectifier or *static excitation systems* must be provided for any new *generating units* with a rating greater than 30 MW or for new smaller *generating units* within a *power station* totalling in excess of 30 MW. *Excitation control systems* must provide *voltage* regulation to within 0.5% of the selected setpoint value.

All synchronous *generating units* with ratings in excess of 30 MW or smaller *generating units* within a *power station* totalling in excess of 30 MW, must incorporate power system stabilise*r* (PSS) circuits which modulate *generating unit* field *voltage* in response to changes in power output and/or shaft speed and/or any other equivalent input signal approved by *Western Power*. 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 30MW or smaller synchronous *generating units* within a *power station* totalling less than or equal to 30MW if *power system* simulations indicate such a requirement. Before commissioning of any *power system* stabiliser, its preliminary settings should be agreed by *Western Power*. The *User* should propose these preliminary settings which should be derived from system simulation studies and the study results reviewed by *Western Power*.

The following performance characteristics are required for ac exciter, rotating rectifier and *static excitation systems*:

Table 3.1
Excitation System Performance Requirements

Performance Item	Units	Static Excitation	AC Exciter or Rotating Rectifier	Notes
***sensitivity*:** A sustained 0.5% error between the *voltage* reference and the sensed *voltage* will produce an *excitation* change of not less than 1.0 per unit.	gain	200 minimum	200 minimum	1
Field *voltage* rise time: Time for field *voltage* to rise from rated *voltage* to *excitation* ceiling *voltage* following the application of a short duration impulse to the *voltage* reference	s	.05 maximum	.5 maximum	2
Settling time with the generator *unsynchronised* following a disturbance equivalent to a 5% step change in the sensed generator terminal *voltage*.	s	1.5 maximum	2.5 maximum	4
Settling time with the generator *synchronised* following a disturbance equivalent to a 5% step change in the sensed generator terminal *voltage*. Must be met at all operating points within the generator capability.	s	2.5 maximum	5 maximum	4
Settling time following any disturbance which causes an *excitation* limiter to operate	s	5 maximum	5 maximum	4

Notes:

1. One per unit is that field *voltage* required to produce nominal *voltage* on the airgap line of the generator open circuit characteristic (Refer IEEE Standard 115-1983 - Test

Procedures for Synchronous Machines). Excitation control system with both proportional and integral actions should achieve a minimum equivalent gain of 200.

2. Rated field *voltage* is that *voltage* required to give nominal generator terminal *voltage* when the generator is operating at its maximum continuous rating. Rise time is defined as the time taken for the field *voltage* to rise from 10% to 90% of the increment value.

3 Settling time is defined as the time taken for the generator terminal *voltage* to settle and stay within an error band of ±1% of its increment value.

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

5 Field voltage means generator field voltage.

The structure and parameter settings of all components of the *excitation control system*, including the *voltage* regulator, *power system* stabiliser, power amplifiers and all *excitation* limiters, must be approved by *Western Power*.

The structure and settings of the *excitation control system* shall not be *changed*, corrected or adjusted in any manner without prior written notification to *Western Power*. *Western Power* may require *generating unit* tests to demonstrate compliance with requirements of Table 3.1. *Western Power* may witness such tests.

Settings may require alteration from time to time as advised by *Western Power*. The preliminary settings backed up by any calculations and system studies to derive these settings must be made available to *Western Power* at least two months before the system tests stated in clause 4.1.3. Any new settings, if found necessary during the tests to improve performance should be provided by the User.

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

3.2.6 Power Station Auxiliary *Transformer*s

In cases where a *power station* takes its auxiliary supplies through a *transformer* via a separate *connection point,* the *User* must comply with the conditions for *connection* of *load*s (Clause 3.3) in respect of that *connection point*.

3.2.7 Synchronising

For a synchronous generating unit the *User* shall provide and install manual or automatic *synchronising* at the generator circuit breakers.

Check *synchronising* shall be provided on all generator circuit breakers and any other circuit breakers, unless interlocked (as outlined in clause 3.4.3.5), that are capable of *connect*ing the *User*'s *generating plant* to the *transmission or distribution network.*

Prior to the initial *synchronisation* of the generating unit(s) to the *transmission or distribution network*, the *User* and *Western Power* shall agree on the operational procedures necessary for *synchronisation*.

3.2.8 Secure Electricity Supplies

Secure electricity supplies of adequate capacity to provide for the operation for at least eight hours of *plant* performing *metering*, communication, monitoring, and *protection* functions, on the loss of AC supplies, must be provided by a *User*.

3.2.9 Design Requirements For *Users' Substations*

Users must comply with the requirements of clause 3.3.5.

3.2.10 Computer Model

Users are required to provide a model suitable for use in the software package which is used by Western Power, currently PSS/E. The model should automatically initialise its parameters from load flow simulations. Once a simulation case has been compiled, changes in the load flow such as changes in voltage, generator output, voltage setpoint shall not require the study case to be recompiled. The model shall to be supported for changes and updates in the nominated software for the duration of connection of the equipment to the network. It is the preference of Western Power that the model be made available to the provider for inclusion in the standard PSS/E library. The source code of the model shall also be provided.

Users are required to demonstrate that the model adequately represents the performance of the physical unit over its load range and over the system frequency operating range of clause 2.2.1, Table 2.1.

The structure and parameter settings of all components of the turbine and excitation control equipment must be provided to *Western Power* in sufficient detail to enable the dynamics of these components to be characterised for short and long term simulation studies. This must include a control block diagram in suitable form to perform dynamic simulations and proposed settings for the turbine *and excitation* control *systems* for all expected modes of turbine control system operation. These parameters must not be varied without prior approval of *Western Powe*r.

The applicable structure and parameter settings shall include but not be limited to :

(1) Speed/*load* controller
(2) Key protection and control loops
(3 Actuators (for example hydraulic valve positioning systems)
(4) Limiters

3.2.11 Plant performance during start-up, shut-down and daily operation

In order to assess the impact of the plant to the grid the proponent should provide the following data: MW, MVAr, and, where applicable, flicker coefficients and harmonic profile of the plant during start-up, shut-down and daily operation / intermittent fuel (wind) variations (for example a typical 24 hour power curve measured at 15-minute intervals or better if available; maximum kVA output over a 60 second interval, etc,).

Measurement of power quality characteristics (including flicker and harmonics) in accordance with IEC 61400-21 shall be provided for all wind turbines proposed for connection to the network.

3.3 REQUIREMENTS FOR *CONNECTION* OF *LOAD*S

The following applies to the *connection* of *load*s to *transmission* and *distribution networks*. It represents typical requirements and particular provisions may be waived for small *Users* and *Users* that have no potential to affect other *Users*, at the discretion of *Western Power.*

A load User must have plant capabilities, protection and control systems sufficient to:

(1) not cause excessive load fluctuations, reactive power draw or, where applicable, stalling of motor loads that would adversely impact other Users or *Western Power*.

(2) not cause any reduction of inter-regional or intra regional power transfer capability based on:

 (i) frequency stability, or

 (ii) voltage stability

 by more than its loading level whenever connected relative to the level that would apply if the load User were disconnected.

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

3.3.1 Information

Before any new or additional equipment is *connected*, the *User* may be required to submit the following kinds of information to *Western Power*:

(a) A single line diagram with the *protection* details.

(b) *Metering system* design details for equipment being provided by the *User*.

(c) A general arrangement locating all the equipment on the site.

(d) A general arrangement for each new or altered *substation* showing all exits and the position of all electrical equipment.

(e) Type test certificates for all new switchgear and *transformers*, including measurement *transformers* to be used for *metering* purposes in accordance with Section 6 (*metering*) of this *Code*.

(f) The proposed methods of earthing cables and other equipment to comply with the relevant *Regulations*.
(g) *Plant* and earth grid test certificates from approved test authorities.
(h) A secondary injection of *protection* and trip test certificate on all circuit breakers.
(i) Certification that all new equipment has been inspected before being *connected* to the *supply*.
(j) Operational procedures.
(k) Details of potentially disturbing *load*s.
(l) *SCADA* arrangements.

In addition, the *User* must provide all data reasonably required by *Western Power*. Details of the kinds of data that may be required are included in Attachment 3.

3.3.2 Design Standards

A *User's* installation must comply with the relevant *Australian Standards* as applicable at the time of first installation in the facility, Electricity (Supply Standard and System Safety) Regulations 2001, *good electricity industry practice* and this *Code*, including, but not limited to, the *power quality* standards as specified in clause 2.2.

All *plant* ratings shall co-ordinate with the equipment installed on the *Western Power power system*.

Users will be responsible for ensuring that *plant* capabilities and ratings are reviewed on an ongoing basis to ensure continued suitability as conditions on the *power system* change in the future (e.g. increasing fault levels, or reduced critical fault clearing times, as additional *plant* is *connected* to the *power system*

If, after installation of a *User' facilities*, it is found that the installation is adversely affecting the security or reliability of the *power system*, the *quality of supply*, or the installation does not comply with the Code or the relevant *access contract* then the *User* shall be responsible for remedying the problem.

3.3.3 User Protection Systems that Impact on Power System Security

Refer to Clause 3.4 for the requirements of *protection system*s for *Users' plant*. The requirements of Clause 3.4 apply only to *protection* which is necessary to maintain *power system security*. *Protection* solely for *User* risks is at the *User's* discretion.

3.3.4 *Power Factor* Requirements

Power factor ranges to be met by load *Users* connected to the *transmission network* are shown in the table 3.2 below:

Table 3.2
Power Factor Requirements (Loads)

Permissible Range	
Supply Voltage (nominal)	*Power factor* Range (half-hour average, unless otherwise specified by *Western Power*)
220kV / 330 kV 66kV / 132 kV <66kV	0.96 lagging to unity 0.95 lagging to unity 0.9 lagging to 0.9 leading

For load Users connected to the *distribution network*, the power factor range to be met by load Users is 0.8 lagging to 0.8 leading, or as otherwise specified in the access contract, where necessary to ensure the satisfactory operation of the distribution network.

Western Power 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 required *power transfer*s.

If the *power factor* falls outside the range specified here any critical *loading* period nominated by *Western Power*, the *User* must, where required by *Western Power* in order to economically achieve required *power transfer* levels, take action to ensure that the *power factor* falls within range as soon as reasonably practicable. This may be achieved by installing additional *reactive plant* or reaching a commercial agreement with *Western Power* to install, operate and maintain equivalent *reactive plant* as part of *connection assets*.

Users who install *shunt capacitors* to comply with *power factor* requirements must comply with *Western Power's* reasonable requirements to ensure that the design does not severely attenuate audio *frequency* signals used for *load* control or operations.

A *User* who installs *static VAr compensator* systems for either *power factor* or *quality of supply* requirements must ensure its control system does not interfere with other normal control functions on the *electricity transmission* and *distribution network*. Adequate filtering *facilities* should be provided if necessary to absorb any excessive harmonic currents.

3.3.5 Design Requirements for *Users*' *Substations*

The following requirements apply to the design, station layout and choice of equipment for a *substation*:

(a) Safety provisions must comply with requirements applicable and notified by *Western Power*;

(b) Where required by *Western Power* appropriate interfaces and accommodation must be incorporated by the *User* for *metering*, communication *facilities*, remote monitoring and *protection* of *plant* which is to be installed in the *substation* by *Western Power*.

(c) A *substation* must be capable of continuous uninterrupted operation with the levels of *voltage*, harmonics, unbalance and *voltage* fluctuation from all sources as defined in Section 2 of this *Code*.

(d) Earthing of *primary plant* in the *substation* must be in accordance with the Electricity *Supply* Association of Australia Safe Earthing Guide, AS3000 and the Western Australian Electrical Requirements. A users earthing system must satisfy the requirements of these publications without any reliance on Western Power facilities.

(e) *Synchronisation facilities* or reclose blocking must be provided if *generating units* are *connected* through the *substation*.

(f) Secure electricity supplies of adequate capacity to provide for the operation for at least eight hours of *plant* performing *metering*, communication, monitoring, and *protection* functions, on loss of AC supplies, must be provided.

(g) *Plant* must be tested to ensure that the *substation* complies with the design and specifications which have been certified as required by clause 3.3.5(k).

(h) The *protection* equipment required would normally include *protection scheme*s for individual items of *plant*, back-up arrangements, auxiliary d.c. supplies and instrumentation *transformers*.

(i) Insulation levels of *plant* in the *substation* must co-ordinate with the insulation levels of the *network* to which the *substation* is *connected* without degrading the design performance of the *network*.

(j) All users, generators and loads, must be able to de-energise their own plant/equipment/substation without reliance on *Western Power*.

(k) Prior to *connection* to the *Western Power power system*, the *User* shall have provided to *Western Power* a signed written statement to certify that the equipment to be *connected* has been designed and installed in accordance with this *Code*, all relevant standards, all statutory requirements, WA Electrical Requirements and *good electricity industry practice*. The statement shall have been certified by a Chartered Professional Engineer with NPER standing with the Institution of Engineers, Australia, unless otherwise agreed.

3.3.6 Load Shedding Facilities

Unless agreed otherwise by *Western Power*, Users are required to provide automatic load shedding facilities in accordance with clause 2.4.

3.3.7 Monitoring and Control Requirements

3.3.7.1 Remote Monitoring

Western Power will require the User to:

I. provide *remote monitoring equipment* ("*RME*") to enable *Western Power* to remotely monitor status and indications of the *load facilities* where this is reasonably necessary in real time for control, planning or security of the *power system*; and

II. upgrade, modify or replace any *RME* already installed in a *user's substation* provided that the existing *RME* is, in the reasonable opinion of *Western Power*, no longer fit for purpose and notice is given in writing to the relevant *User*.

In (I) and (II), the *RME* provided, upgraded, modified or replaced (as applicable) must conform to an acceptable standard as agreed by *Western Power* and must be compatible with *Western Power's SCADA system*, including the requirements of clause 5.12 of this *Code*.

Input Information to *RME* may include, but not be limited to, the following:

(a) Status Indications

(1) relevant circuit breakers open/closed (dual point) within the *plant*
(2) relevant isolators within the *plant*
(3) *connection* to the *transmission or distribution network*
(4) relevant earth switches

(b) Alarms

(1) *protection* operation
(2) *protection* fail
(3) battery fail - AC and DC
(4) *Trip Circuit Supervision*
(5) *Trip Supply Supervision*

(c) Measured Values

(1) *active power load*
(2) *reactive power load*
(3) *load* current
(4) relevant *voltage*s throughout the *plant, including voltage on Western Power side of main switch*

(d) Power Quality Monitoring Equipment.

Western Power may require the User to provide power quality recording equipment at the point of coupling and on the interconnecting lines in order to record key power quality parameters for remote monitoring of power quality indexes to ensure compliance of the requirements in clause 2.2. of this code. *Western Power* will specify, install and operate this equipment.

The key power quality parameters in digital form may include but are not limited to the following :

- Voltage and current harmonic spectrum up to the 50th order.
- Voltage and current unbalance factors
- Profile of transient rms voltage, rms current and average frequency over 5 cycle during system disturbance
- Other parameters reasonably required by *Western Power*.

3.3.7.2 Communications Equipment

A *User* must provide electricity supplies for the *RME* installed in relation to its *plant* capable of keeping these *facilities* available for at least eight hours following total loss of *supply* at the *connection point* for the relevant *plant*.

A *User* must provide communications paths (with appropriate redundancy) between the *RME* installed at its *plant* to a communications interface at the relevant *plant* and in a location reasonably acceptable to *Western Power*. Communications systems between this communications interface and the relevant *control centre* must be the responsibility of *Western Power* unless otherwise agreed

3.3.8 Secure Electricity Supplies

Secure electricity supplies of adequate capacity to provide for the operation for at least eight hours of *plant* performing *metering*, communication, monitoring, and *protection* functions, on loss of AC supplies, must be provided by a *User*.

3.4 *PROTECTION* REQUIREMENTS

The requirements of this clause 3.4 apply only to a *Users' protection* which is necessary to maintain *power system security*. It is the *User's* responsibility to provide adequate *protection* (at the *User's* discretion) of all *User* owned *plant* to ensure the safety of the public and personnel, and to minimise damage. *Protection* installed solely to cover risks associated with a *User's plant* and equipment is at the *User's* discretion. The extent of a *User's plant* and equipment which will need to conform with the requirements of this clause 3.4 will vary from installation to installation. Consequently, each installation will need to be assessed individually by *Western Power*. *Users* will be advised accordingly.

It is important to note that the requirements of this clause 3.4 are designed to adequately protect *Western Power's power system*. The requirements are not necessarily adequate to protect *Users' plant* and equipment. As stated above, *protection* installed solely to cover risks associated with a *User's plant* and equipment is at the *User's* discretion.

3.4.1 Obligation to Provide Adequate *Protection*

3.4.1.1 System Reliability and Integrity

The *connection* of any new *primary plant* to either *Western Power* or *User* owned parts of the system carries with it an obligation on all parties to ensure that the existing reliability and performance of the *power system* is not degraded.

Inclusion of voltage transformers and surge diverters within the operating region of busbar buszone schemes is to be avoided.

To improve grading on the network the transformer type shall be agreed with *Western Power* with preference given to transformers with a zero sequence opening between high-voltage and low-voltage windings and a type that is consistent with Western Power practice.

Where *connection* of new *primary plant* affects *critical fault clearance time*s, it will be necessary to ensure that the performance of the *protection* of both the new and the existing *primary plant* throughout the *power system* meets the new *critical fault clearance time*s and requirements where necessary. Where existing *protection* does not do so, that *protection* shall be upgraded.

Where a *critical fault clearance time* does not exist, there may be other *fault clearance time* requirements imposed by *Western Power* in the interests of system integrity and other *User*s. Typically, these will arise from the need to limit system *voltage* and/or *frequency* disturbances resulting from faults or to prevent critical motor groups from stalling.

Such clearance time requirements may not be known until all new *plant* data is available and the detailed design phase has commenced. Therefore, until clearance times are determined, it shall be assumed that all faults of any type shall need to be cleared within the times specified in section 3.4.2.5.

3.4.2 Overall *Protection* Requirements

3.4.2.1 Minimum Standard of *Protection* Equipment

All *protection* equipment must at least comply with IEC Standard 255.

3.4.2.2 Duplication of *Protection*

Transmission

Two fully independent *protection*s, *connected* to operate in a "one out of two" arrangement, will comprise a complete scheme. To maintain the integrity of the two *protection*s, cross *connection*s between protections are to be avoided. If cross connections are made between protections, sub-fused wiring is to be employed to segregate this wiring from the tripping circuits. Cross connections are not acceptable on trip circuits. Also it must be possible to test and maintain either *protection* without interfering with the other.

To implement the "one out of two" arrangement, complete secondary equipment redundancy is required. This includes *CT* and *VT* secondaries, auxiliary supplies, cabling and wiring, circuit breaker trip coils and batteries. Where both *protection*s require end to end communications, independent *teleprotection signalling* equipment and communication channels must be provided. Further, independent communication bearers are needed for each signalling channel where failure of the signalling will result in neither *protection* meeting its basic *sensitivity* and operating time criteria.

The two fully independent *protection*s may not be dedicated to the one item of *primary plant*. One of the *protection*s may in fact be a *remote backup protection*. Both *protection*s must, however, meet the *critical fault clearance time*s and clearance time requirements of section 3.4.2.5, be located on *User* equipment and discriminate with *Western Power protection*.

Distribution

Duplication of protection is generally not required in distribution networks.

Duplication of protection is required for islanding protection and when *a critical fault clearance time* does exist.

Each item of plant must be protected by two protections, one of which may be a remote backup.

3.4.2.3 Availability of *Protection*

Transmission

A *User* must ensure that all elements of both *protection*s, including associated intertripping, are well maintained so as to be available at all times. Short periods of unavailability of one *protection* (up to 48 hours every 6 months) while maintenance or repair is being carried out is acceptable. Longer periods of unavailability will require the associated *primary plant* to be taken out of service.

Except in an emergency, a *User* must notify *Western Power* at least 5 *business day*s prior to taking a *protection* out of service.

Distribution

The User shall ensure that all it's equipment is protected and that all elements of the protection, including associated intertripping, are available at all times. Unavailability of the protection will require the associated primary plant to be taken out of service.

3.4.2.4 *Protection* Performance Where Critical Fault Clearance Time Exists

Where a *critical fault clearance time* exists on an item of *plant*, that item shall be protected in such a manner that, with any single *secondary plant contingency*, a fault will be detected and cleared within the *critical fault clearance time*.

This shall mean that where a *critical fault clearance time* exists, *plant* shall be protected by *two fully independent protection schemes of differing principle*, each *protection scheme* capable of detecting and clearing *plant* faults within the *critical fault clearance time*. Such an arrangement enables the *critical fault clearance time* to be met even under single *secondary plant contingency* conditions.

3.4.2.5 Maximum Acceptable *Total Fault Clearance Time*

All items of *plant* shall be protected in such a manner that, with any single *secondary plant contingency*, a fault will be detected and cleared within the *critical fault clearance time*.

This shall mean that *plant* shall be protected by *two fully independent protection*s *of* d*iffering principle*, each *protection* capable of detecting and clearing *plant* faults within the required clearance time. Such an arrangement enables the clearance time to be met even under single *secondary plant contingency* conditions.

Regardless of the *critical fault clearance time*, each item of *plant* shall be protected by *two fully independent protections of differing principle*. For all *plant*, except lines 132kV and below, both *protections* are required to meet the clearance times given in Table 3.3 below. For lines 132kV and below, at least one of the *protections* is required to meet the *total fault clearance times* as given in Table 3.3 below. Note that in Tables 3.3 and 3.4 below two sets of fault clearance times are given, one set is acceptable for existing equipment (ie existing at the *code commencement date*). The other set must be used for all new equipment.

Table 3.3
Standard *fault clearance times* (msec) - *South West Interconnected System*

		Existing Equipment No CB Fail	Existing Equipment CB Fail	New Equipment No CB Fail	New Equipment CB Fail
220kV and above	Local	120	370	100	250
	Remote	180	420	140	290
66kV and 132kV	Local	150	400	115	280
	Remote	200	450	160	325

For *voltages* below 66kV in both the *South West Interconnected System* and *North West Interconnected System*, the clearance times will be as specified by *Western Power* in the *access contract*.

Where *critical fault clearance times* exist, *Users* shall maintain a record of design *fault clearance times* for all circuit breakers within their *plant*. This record shall be made available to *Western Power* on request.

For 132kV and 66kV lines, where the *critical fault clearance times* exceed the above times, only one *protection* is required to meet the above times. The other *protection* is required to meet the smaller of the *critical fault clearance time* and the times shown in Table 3.4 below.

Table 3.4
Second *Protection* for 132kV and 66kV Lines Standard *fault clearance times* (msec)
South West Interconnected System

		Existing Equipment No CB Fail	Existing Equipment CB Fail	New Equipment No CB Fail	New Equipment CB Fail
132kV	Local	150	400	115	280
	Remote	400	650	400	565
66kV	Local	1000	>1000	115	280
	Remote	>1000	>1000	400	565

On 132kV lines the second *protection* standard *fault clearance times* will be satisfactory for both *protections* if the line between the *User's substation* and the *Western Power substation* is more than 40km and the *critical fault clearance times* are not exceeded.

66kV lines greater than 40km require one *protection* to meet the clearance times given for 132kV in Table 3.4 and the other *protection* meeting the clearance times for 66kV given in Table 3.4. In both cases the *critical fault clearance times* are not to be exceeded.

In the Tables 3.3 and 3.4, "Local" refers to a fault within the first 65% of the line and "Remote" refers to the last 35% of the line.

3.4.2.6 Sensitivity of Protection

All *protection*s must have sufficient *sensitivity* to detect and correctly clear all *primary plant* faults within their intended normal operating zones, under both normal and *minimum system conditions*. Under abnormal *plant* conditions, all primary system faults must be detected and cleared by at least one *protection* on the *User*'s equipment. *Remote backup protection* or standby *protection* may be used for this purpose.

The *protection* will be considered to have sufficient *sensitivity* if it will detect and correctly clear for half the fault current that will flow for the above conditions.

3.4.2.7 Clearance of *Small Zone Fault*s

*Small zone fault*s shall be detected and cleared by *backup protection* as specified in clause 3.4.3.7. The clearance time requirements for small zone faults are the same as those specified in Clause 3.4.2.5 for Circuit Breaker Fail conditions and for a small zone fault coupled with a single protection failure, clearance times required are 380msec for 220kV and 330kV, and 400msec for 66kV and 132kV. The reliance on remote backup protection shall be reduced by ensuring that circuit breaker fail protection initiates the circuit breaker fail protection of the circuit breakers that they are tripping.

3.4.2.8 Clearance of Faults Under Circuit Breaker Fail Conditions

Failure of a circuit breaker, due to either a mechanical or electrical fault, to clear a fault shall be detected and the primary fault current shall be cleared by *backup protection* as specified in the clause 3.4.3.7.

3.4.2.9 Protection of Interconnections and Ties

The *User* shall provide *protection* to detect and clear faults on the *interconnection* or tie between their system and the *Western Power power system*.

Where a *protection scheme* provides a back up function, it shall have sufficient *sensitivity* to detect and correctly clear all *primary plant* faults within its intended back up operating zone, under both normal and *minimum system conditions*.

It should be noted that where current at the point of fault is composed of multiple contributions, *protection* intended to detect and clear the fault will need sufficient *sensitivity* to detect the contribution current. Generally, such contributions will be less than the *minimum fault current*.

Under abnormal *primary plant* conditions (that may be identified during the detailed design phase) any fault must be detected and cleared by at least one *protection scheme* somewhere in the system. *protection scheme*s affording *remote backup* may be used for this purpose.

3.4.2.10 DC Functions Of *Protection Apparatus*

All *protection apparatus* functions shall be capable of operating with the battery *voltage* at a level of 80% of the nominal DC *supply voltage*. This will generally require circuit breaker trip coils to operate down to 70% of nominal DC *supply voltage*.

3.4.2.11 *Protection* Flagging and Indication

All protective devices supplied to satisfy the *User/Western Power connection* requirements shall be equipped with non volatile operation indicators (flags) or shall be *connected* to an event recorder. Such indicating, flagging and event recording shall be sufficient to enable the determination, after the fact, of which devices caused a particular trip.

Any failure of the User's tripping supplies, Protection Apparatus and circuit breaker trip coils shall be alarmed within the Users installation and operating procedures put in place to ensure that prompt action is taken to remedy such failures.

3.4.2.12 *Trip Supply Supervision* Requirements

All *protection* secondary circuits, where loss of *supply* would result in *protection scheme* performance being reduced, shall have *Trip Supply Supervision*.

3.4.2.13 Trip Circuit Supervision Requirements

All *protection* secondary circuits that include a circuit breaker trip coil shall have *Trip Circuit Supervision*. This equipment is to monitor the trip coil with the circuit breaker in both the open and closed position and alarm for an unhealthy condition.

3.4.2.14 Details of Proposed *User Protection*

Unless otherwise agreed by *Western Power*, *User*s shall provide *Western Power* with full details of proposed *protection* designs, together with all relevant *plant* parameters for Western Power's approval, a minimum of 12 months prior to *energisation* of the protected *primary plant*. Western Power shall provide comments on a *User*'s proposed *protection* designs within 65 *business day*s, unless otherwise agreed.

3.4.2.15 Details of Proposed *User Protection* Settings

Unless agreed otherwise, *User*s shall provide *Western Power* with full details of proposed *protection* settings on all *plant* that may impact on *Western Power's power system* a minimum of 65 *business day*s prior to *energisation* of the protected *primary plant*. Refer to clause 4.2.3.

3.4.2.16 Coordination of *Protection* Settings

The *User* shall ensure that all their *protection* settings coordinate with existing *Western Power protection* settings. Where this is not possible, the *User* will be responsible for revising *Western Power* Settings and upgrading *Western Power* or other *User*s' equipment, where required.

Generally, *Western Power protection* which discriminates on the basis of time employs devices with standard inverse characteristics to BS142 with a 3 second curve at 10 times current and time multiplier of 1.0. Note that this is the specification of the characteristic rather than the device setting. Distance relay zone 2 time is generally set to 300msec.

Specific details of *Western Power protection* are available on request.

3.4.2.17 Commissioning of *Protection*

Western Power reserves the right to witness the commissioning tests on any of the *User*'s *protection* that it deems to be important or critical for the reliable operation and integrity of the *Western Power power system*.

All commissioning and testing of *User* owned *protection* shall be carried out by personnel suitably qualified and experienced in the commissioning, testing and maintenance of *primary plant* and *secondary plant* and equipment.

3.4.2.18 Maintenance of *Protection*

*User*s shall regularly maintain their *protection system*s at intervals of not more than 5 years. Records shall be kept of such maintenance and these may be reviewed by *Western Power*. Refer also to clause 4.1.4.

Each scheduled routine test, or any unscheduled tests which become necessary shall include both a calibration check and an actual trip operation of the associated circuit breaker.

All maintenance and testing of *User* owned *protection* shall be carried out by personnel suitably qualified and experienced in the commissioning, testing and maintenance of *primary plant* and *secondary plant* and equipment.

3.4.3 Specific *Protection* Requirements

3.4.3.1 Transmission Lines and other *Plant* Operated at 66kV and above

Where a *critical fault clearance time* exists, *protection* will be by *two fully independent protections of differing principle*, each one discriminating with the *Western Power power system* and capable of meeting the *critical fault clearance time*.

Where there is no *critical fault clearance time*, *protection* will be by *two fully independent protections of differing principle* that discriminate with the *Western Power power system*. These *protection*s are to meet the *fault clearance time*s specified in clause 3.4.2.5.

In either case, one of the *protection*s shall include earth fault *protection* to give additional coverage for low level earth faults and to provide some *remote backup*.

3.4.3.2 Feeders, Reactors, Capacitors and other *Plant* Operated below 66 kV

Where a *critical fault clearance time* exists, *protection* of these items will be by *two fully independent protections of differing principle*, each one discriminating with the *Western Power power system* and capable of meeting the *critical fault clearance time*. At least one of these *protection*s shall also include earth fault *protection* so as to give additional coverage for low level earth faults and to provide some *remote backup*.

Where there is no *critical fault clearance time*, the following shall be the minimum *protection* requirement:

- Three Phase Inverse Definite Minimum Time Overcurrent
- Three Phase Instantaneous Overcurrent
- Inverse Definite Minimum Time Earth Fault

This *protection* must be backed up by an independent *protection* to ensure clearance of faults with a *protection* failure. The *protection* is also required to discriminate with the *Western Power power system*. Where the *Western Power protection* is overcurrent, the maximum operate time will be 1 second at maximum fault level. Generally, *Western Power* overcurrent and earth fault *protection* employs devices with standard inverse characteristics to BS142 with a 3 second curve at 10 times current and time multiplier of 1.0. Note that this is the specification of the characteristic rather than the device setting. Operating times for other types of *protection* will generally be lower and will be dependent upon location.

3.4.3.3 Transformers

Where a *critical fault clearance time* exists, *protection* will be by *two fully independent protections of differing principle*, each one discriminating with the *Western Power system* and capable of meeting the *critical fault clearance time*.

Where there is no *critical fault clearance time*, *protection* will be by two fully independent *protection*s which are *complementary* and discriminate with the *Western Power power system*. These *protection*s are to meet the *fault clearance time*s specified in clause 3.4.2.5.

Protection of *transformer*s larger than 10 MVA will require at least one of the protections to be a *unit protection* and provide high speed fault clearance of *transformer* faults.

The composition of each of the two fully independent *protection*s should be *complementary* such that, in combination, they provide dependable clearance of *transformer* faults within a specified time. With any single failure to operate of the *secondary plant*, fault clearance must still be achieved by *transformer protection*, but may be delayed until the nature of the fault changes or evolves.

3.4.3.4 Generators

Protection of *generators* shall generally be at the discretion of the *User*, but must be sufficient to protect the generator from faults on the *Western Power power system*. *Protection* will be by *two fully independent protections of differing principle*, each one discriminating with the *Western Power power system*. Where a *critical fault clearance time* exists, each *protection* must be capable of meeting the *critical fault clearance time*. These *protection*s are to meet the *fault clearance time*s specified in clause 3.4.2.5.

In addition, the *User* shall provide *protection* and controls to achieve, even under circuit breaker fail conditions, the following functions:

- Separation of the *User*s *generation* from the *Western Power power system* in the event of any of the above *protection*s operating.

- Separation of the *User*s *generation* from the *Western Power power system* in the event of loss of *supply* to the *User*s installation from the *Western Power power system*.
- Prevention of the *User*s *generation* from *energising de-energised Western Power plant*, or *energising* and *supply*ing an otherwise isolated portion of the *Western Power power system*.
- Adequate *protection* of the *User*s equipment and complete installation without reliance on back up from *Western Power protection*.

3.4.3.5 Check *Synchronising*

Check *synchronising* interlocks shall include a feature such that circuit breaker closure via the check *synchronism* interlock is not possible if the permissive closing contact is closed prior to the circuit breaker close signal being generated. Such a feature is intended to protect the check *synchronism* interlock permissive contact from damage and to ensure out of *synchronism* closure cannot occur if the contact is welded closed.

Distinction should be drawn between check *synchronising* interlocks and *synchronising facilities* (refer to clause 3.2.7).

The check *synchronising* interlocks may be installed on circuit breakers within the *Western Power power system* where the risk of out of *synchronism* closure is unacceptable. This will be installed by *Western Power*.

In addition, the check *synchronising* interlocks shall be installed on all *User*'s circuit breakers capable of out-of-*synchronism* closure, unless otherwise interlocked.

3.4.3.6 *Protection* Alarm Requirements

Specific requirements and the interface point to which alarms shall be provided will be mutually decided during the detailed design phase. These alarms will be brought back to the *Western Power control centre* via the installed *SCADA system* supplied by the *User* in accordance with clause 3.2.5.1 or clause 3.3.7.1, as applicable.

In addition, any failure of the *User*'s tripping supplies, *protection apparatus* and circuit breaker trip coils must be alarmed within the *User*s installation and operating procedures put in place to ensure that prompt action is taken to remedy such failures.

3.4.3.7 Backup Protection

Two fully independent forms of *backup protection* shall be provided to detect and clear faults involving *small zone*s.

Protection shall also be provided to detect and clear faults involving *circuit breaker failure*.

All other faults (such as a small zone fault coupled with a breaker failure) shall be similarly detected and cleared, though it is not expected that system stability would be maintained.

Protection shall also be provided to detect and clear, without system instability, faults, in accordance with clauses 2.3 and 2.5.

Where *critical fault clearance time*s do not exist, or are greater than the times given in section 3.4.2.5, the clearance times are to be as specified by *Western Power* in the *access contract*.

Such *protection scheme*s shall be capable of detecting and initiating clearance of uncleared or *small zone fault*s under both normal and *minimum system conditions*. Under abnormal *plant* conditions, all primary system faults must be detected and cleared by at least one *protection scheme* on the *User*'s equipment. *Remote backup protection* or standby *protection* may be used for this purpose.

3.4.3.8 Islanding of a *User's Facilities* from the *Power System*

Unless otherwise agreed by *Western Power*, a *User* shall ensure that islanding of its *generation plant* together with part of the *Western Power power system*, cannot occur upon loss of *supply* from the *Western Power power system*. This should not preclude a design which allows a *User* to island its own *generation* and *plant load*, thereby maintaining *supply* to that *plant*, upon loss of *supply* from the *Western Power power system*. Islanding must only occur in situations where the *power system* is unlikely to recover from a major disturbance. Unless agreed otherwise by Western Power, islanding based on frequency signal alone should not occur above 47.5 Hz.
Unless otherwise agreed by *Western Power*, the *User* shall provide *facilities* to initiate islanding.

*User*s must co-operate to agree with *Western Power* the type of initiating signal and settings to ensure compatibility with other *protection* settings on the *network* and to ensure compliance with the requirements of clause 2.2.1. Where a *User* does not wish to meet the requirements of clause 2.2.1, appropriate commercial arrangements will be required between the *User*, *Western Power* and/or another *User(s)* to account for the higher level of *access service*.

3.4.3.9 Automatic Reclose Equipment

Automatic reclose equipment is used in limited circumstances in the *Western Power power system* (eg on some radial transmission lines and in distribution). The installation and use of *automatic reclose equipment* in a *User's facility* and in the *power system* shall only be permitted with the prior written agreement of *Western Power*.

3.4.3.10 Circuit Breaker Live Close Inhibit at Western Power Zone Substations

To back up the Facilities islanding protection where there is a reasonable risk of the Users facility islanding with other than own load, Western Power's works for the connection of a generator to a distribution feeder will require the installation of a circuit close inhibit interlock on the feeder circuit breaker at the zone substation.

3.5 REQUIREMENTS FOR *CONNECTION* OF SMALL *GENERATORS TO DISTRIBUTION NETWORK*

This section addresses the particular requirements for small generators and groups of small generators (power stations) of aggregate rated capacity 30 kVA to 10 MW connected to the distribution systems. It does not diminish the obligation of the User to comply with the other requirements of the Technical Rules except where specifically stated in this section.

Whereas most of the requirements of Section 3.2 apply to generators of all sizes, this section identifies those requirements that apply to smaller generators and to identifies additional requirements for small generators connected to the distribution systems.

The issues addressed by this section are:

a) Generators embedded in distribution networks may affect the quality of supply to adjacent distribution connected customers, cause reverse power flows, use up network capacity and increase safety risks for operational personal.

b) It is possible that a distribution connected power station could become 'islanded' on to part of the distribution network when mains supply is lost resulting in safety and quality of supply concerns.

c) Identification of the paragraphs of section 3.2 relevant to small generators.

User's responsibilities

Safety and reliability are paramount and access applications for proposed installations will be evaluated accordingly. In circumstances where it is apparent that safeguards are needed in addition to the requirements of this section, Networks may specify additional performance requirements.

This section is not intended to specify requirements for plant performance other than in those areas that present a risk to the external network and to other users. It is expected that *User*s will design and specify equipment for the facility with reference to good industry practice, industry standards and recommendations of manufacturers.

*User*s must give proper consideration to safety and reliability of plant both internal to the installation and externally and shall be entirely responsible for safety and quality of supply within the facility. It may be necessary for a *User* to augment these requirements to ensure satisfactory safety and performance within the facility.

Evaluation of connection applications will also determine the extent to which the proposed generators(s) will impact other users, use capacity of the existing networks, and interfere with telecommunications and distribution signalling.

3.5.1 Requirements of section 3.2 applicable to small power stations

While not all the requirements of Section 3.2 will apply to distribution connected power stations, Table 3.5 below lists the parts of Section 3.2 that shall apply.

Table 3.5

Paragraphs of Section 3.2 that apply to small distribution connected power stations

30 kVA to 10 MW

3.2	Requirements for connection of generators – preamble
3.2.1	Technical characteristics
3.2.2	Technical matters to be coordinated
3.2.3	Provision of information
3.2.4.1	Reactive Power capability
3.2.4.2	Quality of Electricity generated
3.2.4.3	Generating unit response to disturbances
3.2.4.6	Safe shutdown without external supply
3.2.4.8	Protecting of generating units from power system disturbances
3.2.4.9	User protection systems that impact on system security
3.2.5.3	Turbine control system
3.2.5.4	Excitation control systems
3.2.7	Synchronising
3.2.9	Design requirements for users' substations
3.2.11	Plant performance during start-up, shut-down and daily operation

3.5.2 Facility categories

Generator types

This section addresses all generators, whether renewable energy or non-renewable, of rated aggregate capacity 30 kVA to 10 MW and connected to the distribution networks. It includes but is not limited to the following types:

Synchronous generators
Induction generators
Inverter connected energy sources, both line and self commutated

Connection voltages

High Voltage connected: 3 phase, 6.6kV, 11 kV, 22kV or 33kV
Low voltage connected: 1, 2 or 3 phase plus neutral, 240V or 415V

Modes of operation

Continuous parallel operation: includes generators participating in system peak load management, export or no export.

Short term test paralleling: export or no export, maximum duration of parallel operation 2 hours per event and 10 hours per year.

Bumpless transfer: synchronised for a maximum of one second per event

3.5.3 Connection arrangements

The facility shall contain one Customer Main Switch for each point of connection and one Generator Main Switch for each generator. For a larger installation, additional points of connection and Customer Main Switches or a dedicated feeder may be required.

Switches shall be automatically operated, fault current breaking and making, ganged switches unless otherwise approved. The facility may also contain similarly rated interposed Customer Paralleling Switches for the purpose of providing alternative synchronised switching operations.

3.5.4 Power quality and voltage change

The requirements of section 2.2 POWER QUALITY shall be met with the facility connected to the network.

In addition to this requirement, the change in network voltage resulting from opening or closing the customer main switch or a generator switch shall not exceed 2%.

The voltage rise resulting from export of power to the network shall not exceed 2% and shall not cause operating voltage limits to be exceeded.

3.5.5 Remote monitoring and communications

Remote monitoring of the facility will not be required in all cases. However for large generators, where there is substantial export to the network; where the facility is participating in system peak load management; or where concerns for safety and reliability arise that are not adequately addressed by automatic protections and interlocks, Networks may require remote monitoring of some functions in accordance with sections 3.2.5.1 and 3.2.5.2.

A primary speech facility in accordance with 3.2.5.2 shall be provided for all facilities.

3.5.6 Protection

The *User* shall provide the protection functions specified in Table 3.6 in accordance with the aggregate rated capacity of generators at the point of connection. Compliance with the requirements of this table does not diminish the obligation of the *User* to comply with sections 3.4 and 3.2.4.8. This table addresses only those protections considered necessary for safe and reliable operation of the distribution system and it remains the responsibility of the

User to provide protections internal to the facility as discussed at the beginning of Section 3.5.

Protection relay types and proposed settings shall be approved by Networks. Networks shall perform studies to evaluate proposed protections in the context of distribution system to which connection is proposed and may vary or specify additional requirements to ensure satisfactory quality, safety and reliability.

The User shall provide adequate back-up from other protections to ensure that failure of any one protection shall be detected by neighbouring protections and plant isolated with time delays acceptable to Networks.

Where integrated control and protection equipment is proposed, it shall be demonstrable that the control features are functionally separate from the protection functions.

Table 3.6
Summary of protection requirements for small generators

Protection required for network	Permanent parallel operation					Short term test parallel				Bumpless transfer
	HV generating plant		LV generating plant			HV generating plant	LV generating plant			
	No export	Export	Aggregate capacity kVA			No export	Aggregate capacity kVA			
			<150	150-250	>250		<150	150-250	>250	
Under/over voltage & frequency	*	*	*	*	*	*	*	*	*	*
Loss of mains)	*	*		*	*	*			*	
Overcurrent	*	*	*	*	*	*	*	*	*	*
Earth fault	*	*		*	*	*		*	*	*
Reverse power	*	*			*					
Directional overcurrent	*	*			*					
Neutral voltage displacement	*	*	*	*	*	*	*	*	*	
Loss of DC supply to protection	*	*		*	*	*			*	
Pole slipping	*	*			*					
Disconnection by timer						*	*	*	*	*

Notes:
** indicates required protection*

3.5.6.1 Pole slipping protection

Sustained pole slipping of a generator or group of generators will not be permitted. The *User* must install suitable protections to detect this condition except where it is evident that the level of disturbance resulting from loss of synchronism would not exceed that permitted in Section 2.2. Nevertheless the User may choose to install this protection to mitigate risk of plant damage within the facility.

3.5.6.2 Loss of mains protection and intertripping

For sustained parallel operation, loss of mains protection of two different functional types shall be provided. Operating times for this protection must be coordinated with Network settings for automatic reclosing to ensure disconnection before the first reclosing attempt, (typically 5 seconds).

In cases where the risk of undetected islanding of part of the distribution network and the customer facility remains significant, Networks may also require the installation of an intertripping link between the customer main switch(es) and a feeder circuit breaker(s) in the zone substation.

3.5.6.3 Operating limits

Power system studies may indicate a risk that network ratings or operating limits will be exceeded with the facility connected. As an alternative to network augmentation Networks may require additional protections to ensure that operating limits and agreed import/export limits are not exceeded.

3.5.7 Computer model

For generators rated 3 MW and above, Networks may require the User to provide a computer model for power system simulation studies in accordance with the requirements of section 3.2.10.

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

4.1 INSPECTION AND TESTING

4.1.1 Right of Entry and Inspection

a) *Western Power* or any of its *representatives* (including authorised agents) may, in accordance with clause 4.1, inspect a *facility* of a *User* and the operation and maintenance of that *facility* in order to:

1) assess compliance by the relevant *User* with its operational obligations under the *Access Code* or *Technical Rules*, or an *access contract*; or
2) investigate any possible past or potential threat to *power system security; or*
3) conduct any periodic familiarisation or training associated with the operational requirements of the *facility*.

b) If *Western Power* wishes to inspect the *facilities* of a *User* under clause 4.1.1(a), *Western Power* must give that *User* at least:

- 2 *business days'* notice or as otherwise agreed by the parties, or
- 10 *business days'* notice for a non-urgent issue

in writing of its intention to carry out an inspection. In the case of an emergency condition affecting the *power system* which *Western Power* reasonably considers requires access to the *User's facility*, prior notice is not required, however, *Western Power* shall notify the *User* as soon as practicable after deciding to enter the *User's facility* of the nature and extent of *Western Power's* activities at the *User's facility*.

c) A notice given under clause 4.1.1(b) must include the following information:

1) the name of the *representative* who will be conducting the inspection on behalf of *Western Power*;
2) subject to clause 4.1.1(h), the time when the inspection will commence and the expected time when the inspection will conclude; and
3) if associated with clause 4.1.1(a)(1) then the nature of the suspected non-compliance with the *Rules* or *access contract* , or if associated with clauses 4.1.1(a)(2) or 4.1.1(a)(3) then the relevant reasons for the inspection.

d) *Western Power* may not carry out an inspection under clause 4.1 within 6 months of any previous inspection except for the purpose of verifying the performance of corrective action claimed to have been carried out in respect of a non-conformance observed and documented on the previous inspection or for the purpose of investigating an operating incident in accordance with clause 5.8.11.

e) At any time when the *representative* of *Western Power* is in a *User*'s *facility*, that *representative* must:

1) cause no damage to the *facility;*
2) only interfere with the operation of the *facility* to the extent reasonably necessary and approved by the relevant *User* (such approval not to be unreasonably withheld or delayed);
3) observe "permit to test" access to sites and clearance protocols of the operator of the *facility*, provided that these are not used by the *facility* solely to delay the granting of access to site and inspection;
4) observe the requirements of the operator of the *facility* in relation to occupational health and safety and industrial relations matters, which requirements are of general application to all invitees entering on or into the *facility*, provided that these are not used by the *facility* solely to delay the granting of access to site and inspection; and
5) not ask any question other than as reasonably necessary for the purpose of such inspection or give any *direction*, instruction or advice to any person involved in the operation or maintenance of the *facility* other than the operator of the *facility* or unless approved by the operator of the *facility*.

f) Any *representative* of *Western Power* 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 *User*, *Western Power* shall procure that a *representative* of *Western Power* (other than an employee) gaining access under these *Rules* or an *access contract* enters into a confidentiality undertaking in favour of the *User* in a form reasonably acceptable to the *User* prior to gaining such access.
g) Any inspection under clause 4.1.1(a) must not take longer than one *day* unless *Western Power* seeks approval from the *User* for an extension of time (such approval not to be unreasonably withheld or delayed).

h) Any equipment or goods installed or left on land or in premises of a *User* after an inspection conducted under clause 4.1.1 do not become the property of the relevant *User* (notwithstanding that they may be annexed or affixed to the relevant land or premises).

i) In respect of any equipment or goods left on land or premises of a *User* during or after an inspection, a *User*:

1) must not use any such equipment or goods for a purpose other than as contemplated in these *Rules* without the prior written approval of the owner of the equipment or goods;
2) must allow the owner of any such equipment or goods to remove any such equipment or goods in whole or in part at a time agreed with the relevant *User* with such agreement not to be unreasonably withheld or delayed;
3) must not create or cause to be created any mortgage, charge or lien over any such equipment or goods; and

4.1.2 Right of Testing

(a) If *Western Power* has reasonable grounds to believe that equipment owned or operated by a *User* may not comply with the *Access Code, Rules* or the *access contract, Western Power* may require testing of the relevant equipment by giving notice in writing to the *User*.

(b) If a notice is given under clause 4.1.2(a) the relevant test is to be conducted at a reasonable time mutually agreed by the parties.

(c) The *User* who receives a notice under clause 4.1.2(a) must co-operate in relation to conducting tests requested under clause 4.1.2(a).

(d) Tests conducted in respect of a *connection point* under clause 4.1.2 must be conducted using test procedures agreed between the relevant *Users,* which agreement is not to be unreasonably withheld or delayed.

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

(g) If *Western Power* requests a test under this clause 4.1.2, *Western Power* may appoint a *representative* to witness a test and the relevant *User* must permit a *representative* appointed under this clause 4.1.2(g) to be present while the test is being conducted.

(h) Subject to clause 4.1.2(i), a *User* who conducts a test must submit a report to *Western Power* within a reasonable period after the completion of the test and the report is to outline relevant details of the tests conducted, including but not limited to the results of those tests.

(i) If a performance test or monitoring of in-service performance demonstrates that equipment owned or operated by a *User* does not comply with the *Access Code,* these *Rules* or the relevant *access contract* then the *User* must:

(1) promptly notify *Western Power* of that fact; and
(2) promptly advise *Western Power* of the remedial steps it proposes to take and the timetable for such remedial work; and
(3) diligently undertake such remedial work and report at monthly intervals to *Western Power* 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.

(j) *Western Power* may attach test equipment or *monitoring equipment* to *plant* 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.

(k) In carrying out monitoring under clause 4.1.2(j), *Western Power* must not cause the performance of the monitored *plant* to be *constrained* in any way.

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

(a) Each User must provide evidence to Western Power that each of its generating units complies with the technical requirements of Clause 3.2 and the relevant access contract. In addition, each User must provide facilities to carry out power system tests prior to commercial operation in order to verify acceptable performance of each generating unit, and provide information and data necessary for computer model validation. These test requirements, primarily for synchronous generators are detailed in Table A10.1 of Attachment 9. Western Power will specify test requirements for other forms of non-synchronous generation.

Other special tests may be specified by Western Power, and Users will be advised accordingly. Examples of some of these special tests are listed in Table A10.2 of Attachment 9. Where testing is not practical, Western Power may request a User to install recording equipment at appropriate locations in order to confirm compliance of performance.

These tests shall only be performed after the machines have been tested and certified by a Chartered Professional Engineer with NPER standing with the Institution of Engineers, Australia, unless otherwise agreed. Also, that the machine's turbine controls, AVR, excitation limiters, power system stabiliser, and associated protection functions have been calibrated and tuned for commercial operation to ensure stable operation both on-line and off-line. All final settings of the AVR, PSS, excitation limiters should be indicated on the control transfer block diagrams and made available to Western Power before the tests.

The User shall forward test procedures which incorporate test requirements in Attachment 9 and details of the recorders and measurement equipment to be used in the tests to Western Power for approval 30 business days before the tests. The User is responsible for providing all necessary recorders and other measurement equipment for the tests.

The User is also responsible for coordinating the tests and liaising with all parties involved including Western Power System Control Centre. A representative from Western Power may witness the test to ensure compliance of performance and data requirements. Western Power will indicate if such witnessing is required. The Western Power representative will be on site for the purpose of witnessing tests only and not to give any formal approvals or permissions related to the testing.

All test results and associated relevant information including final transfer function block diagrams and settings of AVR, PSS, UEL and OEL shall be forwarded to Western Power within 10 business days after the test.

(b) Each *User* must negotiate in good faith with *Western Power* to agree on a compliance monitoring program, including an agreed method, for each of its *generating units* to confirm ongoing compliance with the applicable technical requirements of Clause 3.2 and the relevant *access contract.* The negotiations should consider first the use of high speed data recorders and similar non-invasive methods for verifying the plant performance.

(c) If a performance test or monitoring of in-service performance demonstrates that a *generating unit* is not complying with one or more technical requirements of Clause 3.2 and the relevant *access contract* then the *User* must:

(1) promptly notify *Western Power* of that fact; and
(2) promptly advise *Western Power* of the remedial steps it proposes to take and the timetable for such remedial work; and

(3) diligently undertake such remedial work and report at monthly intervals to *Western Power* 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 *Western Power* reasonably believes that a *generating unit* is not complying with one or more technical requirements of Clause 3.2 and the relevant *access contract, Western Power* may instruct the *User* to conduct tests within 25 *business days* 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) *Western Power* must reimburse the *User* for the reasonable expenses incurred as a direct result of conducting the tests.

(e) If *Western Power*:

(1) is satisfied that a *generating unit* does not comply with one or more technical requirements; and

(2) does not have evidence demonstrating that a *generating unit* complies with the technical requirements set out in Clause 3.2; or

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

Western Power may direct the relevant *User* to operate the relevant *generating unit* at a particular *generated* output or in a particular mode until the relevant *User* submits evidence reasonably satisfactory to *Western Power* that the *generating unit* is complying with the relevant technical requirement.

(f) A *direction* under clause 4.1.3(e) must be recorded by *Western Power*.

(g) From the *Rules commencement date* or from the date of access, whichever is the later, each *User* 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 *Western Power* on request.

4.1.4 Routine Testing of *Protection* Equipment

a) Subject to clause 3.4.2.18, a *User* must cooperate with *Western Power* 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 *plant* at the relevant *connection point* being placed in service; and

2) at intervals specified in the *access contract* or in accordance with an asset management plan agreed between *Western Power* and the *User*.

b) A *User* shall, on request from *Western Power*, demonstrate to *Western Power*'s satisfaction the correct calibration and operation of the *User*'s protective devices.

4.1.5 Testing by *User*s of their own *Plant* Requiring Changes to Agreed Operation

(a) A *User* proposing to conduct a test on equipment related to a *connection point,* which requires a change to the operation of that equipment as specified in the *access contract*, must give notice in writing to *Western Power* of at least 15 *business days* except in an emergency.

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

(1) the nature of the proposed test;
(2) the estimated start and finish time for the proposed test;
(3) the identity of the equipment to be tested;
(4) the *power system* conditions required for the conduct of the proposed test;
(5) details of any potential adverse consequences of the proposed test on the equipment to be tested;
(6) details of any potential adverse consequences of the proposed test on the *power system*; and
(7) the name of the person responsible for the coordination of the proposed test on behalf of the *User*.

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

(d) If, in *Western Power's* reasonable opinion, a test could threaten public safety, damage or threaten to damage equipment or adversely affect the operation of the *power system*, *Western Power* may direct that the proposed test procedure be modified or that the test not be conducted at the time proposed.

(e) *Western Power* must advise any other *User*s who will be adversely affected by a proposed test and consider any reasonable requirements of those *User*s 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 a test promptly advises *Western Power* when the test is complete.

(g) If *Western Power* approves a proposed test, *Western Power* must use its reasonable endeavours to 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 *Western Power* 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) *Western Power* may, at intervals of not less than 12 months per *generating unit*, require the testing by a *User* of any *generating unit connected* to the *network* of *Western Power* in order to determine analytic parameters for modelling purposes or to assess the performance of the relevant *generating unit* and *Western Power* is entitled to witness such tests. *Western Power* must have reasonable grounds for requiring such tests.

(b) Adequate notice of not less than 15 *business days* must be given by *Western Power* to the *User* before the proposed date of a test under clause 4.1.6(a).

(c) *Western Power* must use its reasonable endeavours to ensure that tests permitted under this clause 4.1.6 are to be conducted at a time which will minimise the departure from the *commitment* that is due to take place at that time .

(d) If not possible beforehand, a *User* must conduct a test under clause 4.1.6 at the next scheduled *outage* of the relevant *generating unit* and in any event within 9 months of the request.

(e) A *User* must provide any reasonable assistance requested by *Western Power* in relation to the conduct of tests.

(f) Tests conducted under clause 4.1.6 must be conducted in accordance with test procedures agreed between *Western Power* and the relevant *User* and a *User* must not unreasonably withhold its agreement to test procedures proposed for this purpose by *Western Power*.

(g) *Western Power* must provide to a *User* such details of the analytic parameters of the model derived from the tests referred to in clause 4.1.6 for any of that *User's generating units* as may reasonably be requested by the *User*.

4.1.7 *Power System* Tests

(a) Tests conducted for the purpose of either verifying the magnitude of the *power transfer capability* of *transmission networks* or investigating *power system* performance must be coordinated and approved by *Western Power*. *Western Power* or a *User* requesting such tests must have reasonable grounds for requiring such tests.

(b) The tests described in clause 4.1.7(a) may be conducted whenever:

(1) a new *generating unit* or *facility* of a *Customer, User* or a *network* development is commissioned that is calculated or anticipated to substantially alter *power transfer capability* through the *transmission network*;
(2) setting changes are made to any *turbine control system* and *excitation control system*, including *power system* stabilisers; or
(3) a test is required to verify the performance of the *power system* or to validate computer models.

(c) *Western Power* must notify all *Users* which 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 reasonable requirements of those *Users* when approving the proposed test.

(d) Operational conditions for each test must be arranged by *Western Power* and the test procedures must be coordinated by an officer nominated by *Western Power* 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.

(e) Each *User* must cooperate with *Western Power* when required in planning, preparing for and conducting *transmission* and *distribution network tests* to assess the technical performance of the *networks* and if necessary conduct co-ordinated activities to prepare for *power system* wide testing or individual, on-site tests of the *User's facilities* or *plant,* including *disconnection* of a *generating unit*.

(f) *Western Power* may direct operation of *generating units* by *Users* during *power system tests* if this is necessary to achieve operational conditions on the *transmission* and *distribution networks* which are reasonably required to achieve valid test results.

(g) *Western Power* must plan the timing of tests so that the variation from *dispatch* that would otherwise occur is minimised and the duration of the tests is as short as possible consistent with test requirements and *power system security*.

4.2 COMMISSIONING

4.2.1 Requirement to Inspect and Test Equipment

(a) A *User* must ensure that any of its new or replacement equipment is inspected and tested to demonstrate that it complies with relevant *Australian Standards*, relevant international standards, these *Rules, Access Code* and any relevant *access contract* prior to or within an agreed time after being *connected* to a *transmission* or *distribution network,* and *Western Power* is entitled to witness such inspections and tests.

(b) The *User* must produce test certificates on request by *Western Power* showing that the equipment has passed the tests and complies with the standards set out in clause 4.2.1(a) before *connection* to the *power system*, or within an agreed time thereafter.

4.2.2 Co-ordination During Commissioning

A *User* seeking to *connect* to a *network* must cooperate with *Western Power* 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 any other *User's* equipment.

4.2.3 Control and *protection* settings for equipment

(a) Not less than 65 *business day*s prior to the proposed commencement of commissioning of any new or replacement equipment that could reasonably be expected to alter performance of the *power system*, the *User* must submit to *Western Power* 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) *Western Power* must*:*

(1) consult with other *Users* as appropriate; and
(2) within 20 *business days* of receipt of the design information under clause 4.2.3(a), notify the *User* of any comments on the proposed parameter settings for the new or replacement equipment.

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

(d) *Western Power* 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 referred to the *Referee*.

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

4.2.4 Commissioning Program

(a) Not less than 65 *business day*s prior to the proposed commencement of commissioning by a *User* of any new or replacement equipment that could reasonably be expected to alter performance of the *power system*, the *User* must advise *Western Power* in writing of the commissioning program including test procedures and proposed test equipment to be used in the commissioning.

(b) *Western Power* must, within 20 *business days* of receipt of such advice under clause 4.2.4(a), notify the *User* either that it:

(1) agrees with the proposed commissioning program and test procedures; or
(2) requires changes in the interest of maintaining *power system security*, safety or *quality of supply*.

(c) If *Western Power* requires changes, then the parties must co-operate to reach agreement and finalise the commissioning program within a reasonable period.

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

4.2.5 Commissioning Tests

(a) *Western Power* has the right to witness commissioning tests relating to new or replacement equipment that could reasonably be expected to alter performance of the *power system* or the accurate *metering* of *energy*, including *SCADA* equipment.

Prior to *connection* to the *Western Power power system*, the *User* shall have provided to *Western Power* a signed written statement to certify that the equipment to be *connected* has been installed in accordance with the *Access Code,* these *Rules*, the relevant *access contract*, all relevant standards, all statutory requirements and *good electricity industry practice*. The statement shall have been certified by a Chartered Professional Engineer with NPER standing with the Institution of Engineers, Australia, unless otherwise agreed.

(b) *Western Power* must, within a reasonable period of receiving advice of commissioning tests, notify the *User* whose new or replacement equipment is to be tested under this clause 4.2.5 whether or not it:

(1) wishes to witness the commissioning tests; and
(2) agrees with the proposed commissioning times.

(c) A *User* whose new or replacement equipment is tested under this clause 4.2.5 must submit to *Western Power* the commissioning test results demonstrating that a new or replacement item of equipment complies with these *Rules* or the relevant *access contract* or both to the satisfaction of *Western Power.*

(d) If the commissioning tests conducted in relation to a new or replacement item of equipment demonstrates non-compliance with one or more requirements of these *Rules* or the relevant *access contract* then the *User* whose new or replacement equipment was tested under this clause 4.2.5 must promptly meet with *Western Power* to agree on a process aimed at achievement of compliance of the relevant item with these *Rules*.

(e) *Western Power* may direct that the commissioning and subsequent *connection* of the *User's* equipment should not proceed if the relevant equipment does not meet the technical requirements specified in clause 4.2.1.

(f) All commissioning and testing of *User* owned equipment shall be carried out by personnel experienced in the commissioning of *power system primary plant* and *secondary plant*.

4.3 *DISCONNECTION* AND RE*CONNECTION*

4.3.1 Voluntary *Disconnection*

(a) Unless agreed otherwise and specified in an *access contract*, a *User* must give to *Western Power* notice in writing of its intention to permanently *disconnect* a *facility* from a *connection point*.

(b) A *User* is entitled, subject to the terms of the relevant *access contract*, to require voluntary permanent *disconnection* of its equipment from the *power system* in which case appropriate operating procedures necessary to ensure that the *disconnection* will not threaten *power system security* must be implemented in accordance with clause 4.3.2.

4.3.2 Decommissioning Procedures

(a) In the event that a *User*'s facility is to be permanently *disconnected* from the *power system*, whether in accordance with clause 4.3.1 or otherwise, *Western Power* and the *User* must, prior to such *disconnection* occurring, follow agreed procedures for *disconnection*.

(b) *Western Power* must notify other *Users* if it believes, in its reasonable opinion, the terms and conditions of such a *access contract* will be affected by procedures for *disconnection* or proposed procedures agreed with any other *User*. The parties must negotiate any amendments to the procedures for *disconnection* or the *access contract* that may be required.

(c) Any *disconnection* procedures agreed to or determined under clause 4.3.2(a) must be followed by *Western Power* and all *Users*.

4.3.3 Involuntary *Disconnection* (refer also to clause 5.8)

a) *Western Power* may *disconnect* a *User's facilities* from a *network :*

1) during an emergency in accordance with clause 4.3.5;
2) in accordance with relevant laws; or
3) in accordance with the provisions of the *User's access contract.*

b) In all cases of *disconnection* by *Western Power* during an emergency in accordance with clause 4.3.5*, Western Power* is required to undertake a review under clause 5.8.11 and *Western Power* must then provide a report to the *User* advising of the circumstances requiring such action.

4.3.5 *Disconnection* During an Emergency

Where *Western Power* may *disconnect* a *User's facilities* during an emergency under these *Rules* or otherwise, then *Western Power* 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 *Western Power's* reasonable opinion, it is not appropriate to follow the procedure set out in clause 4.3.5(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.*

4.3.6 Obligation to Re*connect*

Western Power must re*connect* a *User*'s *facilities* to a *transmission* or as soon as practicable if:

(a) a breach of the Access *Code, Rules* or *access contract* giving rise to *disconnection* has been remedied; or
(b) the *User* has taken all necessary steps to prevent the re-occurrence of the breach and has delivered binding undertakings to *Western Power* that the breach will not re-occur.

5. POWER SYSTEM SECURITY

5.1 INTRODUCTION

5.1.1 Purpose and Application of Section 5

(a) This Section of the *Rules,* which applies to, and defines obligations for all *Users:*
- (1) provides the framework for achieving and maintaining a secure *power system*;
- (2) provides the conditions under which *Western Power* issue *directions* to *Users* so as to maintain or re-establish a secure *power system*;
- (3) has the following aims:
  - (i) to detail the principles and guidelines for achieving and maintaining *power system security*;
  - (ii) to establish the processes for the assessment of the adequacy of *power system* reserves;
  - (iii) to establish processes and arrangements to enable *Western Power* to plan and conduct operations within the *power system* to achieve and maintain *power system security*; and
  - (iv) to establish arrangements for the actual *dispatch* of *generating units* and *loads* by *Users*.

(b) By virtue of this Section, *Western Power* has responsibility for *power system security*.

5.2 *POWER SYSTEM SECURITY* DEFINITIONS AND PRINCIPLES

This clause sets out certain definitions and concepts that are relevant to Section 5 of the *Rules*.

A fundamental security principle, that generally applies to all transmission plant in the power system, is that a single fault shall not cause disconnection of equipment beyond its fault clearing zone. This principle does not apply to parts of the system designed to the (N-0) criterion or those protected by remedial action schemes.

Security of a power system refers to the degree of risk in its ability to survive imminent disturbances (contingencies) without interruption of customer service. It relates to robustness of the system to imminent disturbances and, hence, depends on the system operating condition as well as the contingent probability of disturbances.

5.2.1 *Satisfactory Operating State*

The *power system* is defined as being in a *satisfactory operating state* when:

a) the *frequency* at all energised *busbars* of the *power system* is in accordance with the frequency operating standards as specified in Table 2.1;

b) the *voltage* magnitudes at all energised *busbars* of the *transmission* and *distribution network* are within the relevant limits set by *Western Power* in accordance with these Rules and clause 2.2.2 of these Rules;

c) the current flows on all *transmission and distribution lines* of the *transmission and distribution network* are within the ratings (accounting for time dependency in the case of emergency ratings) as defined by *Western Power*;

d) all other *plant* forming part of or impacting on the *power system* is being operated within the relevant operating ratings (accounting for time dependency in the case of emergency ratings) as defined by *Western Power*;

(e) the configuration of the *transmission and distribution network* is such that the severity of any potential fault is within the capability of transmission and distribution circuit breakers and distribution reclosers/switches to *disconnect* the faulted circuit or equipment; and

(f) the conditions of the *power system* are stable in accordance with requirements designated in or under clause 2.3.

5.2.2 Secure Operating State

(a) The *power system* is defined to be in a *secure operating state* if, in *Western Power's* reasonable opinion, taking into consideration the appropriate *power system security* principles described in clause 5.2.4:

(1) the *power system* is in a *satisfactory operating state*; and

(2) The *power system* can be promptly returned to a *satisfactory operating state* following the occurrence of *credible contingency events* (events considered in accordance with clause 2.5 of these Rules) with the *frequency and voltage* remaining within the limits specified in clauses 5.2.1(a) and 5.2.1(b), respectively.

(b) Without limitation, in forming the opinions described in clause 5.2.2(a), *Western Power* must:

(1) consider the impact of each of the potentially *constrained interconnectors*; and

(2) use the *technical envelope* as the basis of determining events considered to be *credible contingency events* at that time.

(c) A part of the *power system* is considered to be in a *secure operating state*, even though *Western Power* considers the provisions of clause 5.2.2(a)(2) to be not satisfied, where:

(1) The design of that part of *power system* does not meet this level of security; and

(2) the *Users* connected to that part of the *transmission or distribution network* have accepted such lower level of security. A *User* is considered to have accepted such lower level of security in relation to a part of the *power system* so designed unless the c*onnection contract* between that *User* and *Western Power* provides otherwise; and

(3) *Users* have provided automatic and/or manually *interruptible load* in accordance with their *access contract* and these Rules.

5.2.3 *Technical Envelope*

(a) The *technical envelope* means the technical boundary limits of the *power system* for achieving and maintaining the *secure operating state* of the *power system* for a given demand and *power system* scenario.

(b) *Western Power* must determine and revise the *technical envelope* (as may be necessary from time to time) by taking into account the prevailing *power system* and *plant* conditions as described in clause 5.2.3(c).

(c) The *technical envelope* determination must take into account matters including but not limited to:

(1) the *Western Power* forecast total *power system load*;

(2) the provision of the applicable *contingency capacity reserves*;

(3) operation within all *plant* capabilities and *constraints* on the *power system*;

(4) *contingency capacity reserves* available to handle *credible contingency events* in accordance with clause 2.5 of these Rules;

(5) agreed *generation load constraints*;

(6) *constraints* on the *transmission* and *distribution network*, including short term limitations;

(7) *frequency* control requirements;

(8) *reactive power* support and *ancillary services* requirements; and

(9) the existence of proposals for any major equipment or *plant* testing, including the checking or possible changes in *transmission/distribution plant* availability.

(10) The performance standards.

5.2.4 General Principles for Maintaining *Power System Security*

The *power system security* principles are as follows:

(a) To the extent practicable, the *power system* should be operated such that it is and will remain in a *secure operating state.*

(b) Following a *credible contingency event* or a significant *change* in *power system* conditions, it is possible that the *power system* may no longer be in a condition which could be considered secure on the occurrence of a further *contingency event*. In that case, *Western Power* should take all reasonable actions to adjust, wherever possible, the operating conditions with a view to returning the *power system* to its *secure operating state* as soon as it is practical to do so, and, in any event, within thirty minutes.

(c) Adequate *load shedding facilities* initiated automatically by *frequency* or *voltage* conditions outside the *normal operating frequency or voltage excursion band* should be available and in service to restore the *power system* to a *satisfactory operating state* following significant *contingency events*.

(d) *Users* shall be required, either under their *access contracts*, to provide and maintain all required *facilities* consistent with both their *access contract* and *good electricity industry practice* and operate their equipment in a manner:

(1) to assist in preventing or controlling instability within the *power system*;

(2) to assist in the maintenance of, or restoration to a *satisfactory operating state* of the *power system*;

(3) to prevent uncontrolled separation of the *transmission and distribution network* into isolated *regions* or partly combined *regions*, *intra-regional*

transmission break-up, or *cascading outages*, following any *power system* incident; and

(4) in accordance with the technical requirements of their *access contract*

(e) *Users* shall arrange sufficient *black start-up* provisions so as to allow the restoration and any necessary restarting of their *generating units* following a *black system* condition.

5.2.5 Time for Undertaking Action

An event which is required under Section 5 of the *Rules* to occur on or by a stipulated *day* must occur on or by that *day* whether or not a *business day*.

5.3 *POWER SYSTEM SECURITY* RESPONSIBILITIES AND OBLIGATIONS

5.3.1 Responsibility of *Western Power* for *Power System Security*

The *Western Power power system security responsibilities* are:

(a) to maintain *power system security*;

(b) to take reasonable steps to ensure that *high voltage* switching procedures and arrangements are utilised by *Users* to provide adequate *protection* of the *power system*;

(c) to assess potential infringement of the *technical envelope* or *power system operating procedures* which could affect the security of the *power system*;

(d) to operate the *power system* within the limits of the *technical envelope*;

(e) to operate all *plant* and equipment under its control or co-ordination within the appropriate operational or emergency limits which are either established by *Western Power* or advised by the respective *Users*;

(f) to assess the impacts of any technical and operational *constraints* on the operation of the *power system*;

(g) to monitor the *dispatch* of *generating units* and *associated loads* to ensure they stay within both their allowable limits and the dynamic limits of the *technical envelope*;

(h) to determine any potential *constraint* on the *operation* of *generating units* and *loads* and to assess the effect of this *constraint* on the maintenance of *power system security*;

(i) to assess the availability and adequacy, including the dynamic response, of *contingency capacity reserves* and *reactive power reserves* in accordance with Section 2 of these Rules and to take reasonable steps to ensure that appropriate levels of *contingency capacity reserves* and *reactive power reserves* are available:

(1) to ensure the *power system* is, and is maintained, in a *satisfactory operating state*; and

(2) to arrest the impacts of a range of significant multiple *contingency events* (affecting up to 90% of the total *power system load*) to allow a prompt restoration or recovery of *power system security* , taking into account under-*frequency or under voltage* initiated *load shedding* capability provided under *access contracts* or as otherwise;

(j) to make available to *Users* as appropriate, information about the potential for, or the occurrence of, a situation which could significantly impact, or is significantly impacting on *power system security.*

(k) to refer to other *Users*, as *Western Power* deems appropriate, information of which *Western Power* becomes aware in relation to significant risks to the *power system* where actions to achieve a resolution of those risks are outside the responsibility or control of *Western Power*;

(l) to utilise resources and services provided or procured as *ancillary services* or otherwise to maintain or restore the *satisfactory operating state* of the *power system;*

(m) to co-ordinate the operation of *black start-up facilities* in response to a partial or total *black system* condition sufficient to re-establish a *satisfactory operating state* of the *power system*;

(n) to interrupt, subject to clause 5.3.2, *User connections* as necessary during emergency situations to facilitate the re-establishment of the *satisfactory operating state* of the *power system*;

(o) to direct (as necessary) any *User* to take action necessary to ensure, maintain or restore the *power system* to a *satisfactory operating state*;

(p) to co-ordinate and direct any rotation of widespread interruption of demand in the event of a major *supply* shortfall or disruption;

(q) to determine the extent to which the levels of *contingency capacity reserves* and *reactive power reserves* are or were appropriate through appropriate testing, auditing and simulation studies;

(r) to investigate and review all major transmission *network power system* operational incidents and to initiate action plans to manage any abnormal situations or significant deficiencies which could reasonably threaten *power system security.* All *User's* shall co-operate with such action plans. Such situations or deficiencies include without limitation:

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

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

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

   (4) unplanned/unexpected operation of major *power system* equipment.

5.3.2 *Western Power*'s Obligations

(a) *Western Power* must use its reasonable endeavours, as permitted under the *Access Code*, including through the provision of appropriate information to *Users* to the extent permitted by law and under these Rules, to achieve the *Western Power power system* safety and *security responsibilities* in accordance with *power system security* principles and *good electricity industry practice*.

(b) Where an obligation is imposed on *Western Power* under this Section of the *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 for *Western Power* to use reasonable endeavours as permitted under the *Access Code*, including to give such *direction*s as are within its powers, to comply with that obligation.

(c) If *Western Power* fails to arrange or control any act, matter or thing or the acts of any other person notwithstanding the use of *Western Power's* reasonable endeavours, *Western Power* will not be taken to have breached such obligation.

(d) *Western Power* must make accessible to *Users* such information as:

(1) *Western Power* considers appropriate;

(2) *Western Power* is permitted to disclose in order to assist *Users* to make appropriate market decisions related to open access *to Western Power's transmission* and *distribution networks*; and

(3) *Western Power* is able to disclose to enable *Users* to consider initiating procedures to manage the potential risk of any necessary action by *Western Power* to restore or maintain *power system security*,

provided that, in doing so, *Western Power* must use reasonable endeavours to ensure that such information is available to those *Users* who request the information on an equivalent basis.

In the event that Western Power, in its reasonable opinion for reasons of safety to the public, Western Power personnel, *Users*' equipment or Western Power equipment or for *power system security*, needs to interrupt supply to any *User* of the transmission system, Western Power will (time permitting) consult with the relevant *User* prior to executing that interruption. At the distribution system level, the consultations are generally impractical because of the large number of customers.

If the network is operating outside the permissible limits, *Users* may be disconnected.

Western Power must arrange controls, monitoring and secure communication systems which are appropriate in the circumstances to facilitate a manually initiated, rotational *load shedding* and restoration process which may be necessary if there is, in *Western Power's* opinion, a prolonged major *power system* disruption.

5.3.3 *User* Obligations

(a) Users must ensure that appropriately qualified and competent persons undertake distribution and transmission network operations performed on their behalf.

(b) All *User*s must co-operate with and assist *Western Power* in the proper discharge of the *Western Power power system security responsibilities*.

(c) All *Users* must operate their *facilities* and equipment in accordance with any reasonable *direction* given by *Western Power*.

(d) All *Users* must provide automatic *interruptible load* in accordance with clause 2.4.

(e) *User's* must provide their *interruptible load* in manageable blocks spread over a number of steps within under-*frequency* bands from 49.0 Hz down to 47.0 Hz as nominated by *Western Power*.

5.4 *POWER SYSTEM* FREQUENCY CONTROL

5.4.1 *Power System* Frequency Control Responsibilities

Western Power must use its reasonable endeavours to:

(a) control the *power system frequency* and associated time error; and

(b) ensure that the *power system frequency operating standards* set out in these *Rules* are achieved.

5.4.2 Operational Frequency Control Requirements

To assist in the effective monitoring of *power system frequency* by *Western Power* the following provisions apply:

(a) The power to control and direct the output of all *generating units* and supply to *loads* is given to *Western Power* pursuant to clause 5.9.

(b) Each *User* must ensure that all of its *generating units* have automatic and responsive turbine speed control *systems* and automatic *load* control schemes in accordance with the requirements of clause 3.2, so as to automatically adjust for *changes* in associated *power* demand or loss of *generation* as it occurs through response to the resulting excursion in *power system frequency* and *associated load*.

(c) *Western Power* must use its reasonable endeavours to arrange to be available and specifically allocated to *regulating duty* such *generating plant* as *Western Power* considers appropriate which can be automatically controlled or directed by *Western Power* to ensure that normal *load* variations do not result in *frequency* deviations outside the limitations specified in clause 5.2.1(a).

(d) *Western Power* must use its reasonable endeavours to arrange *ancillary services* and contractual arrangements associated with the availability, responsiveness and control of necessary *contingency capacity reserve* and the rapid un*load*ing of *generation* as may be reasonably necessary to cater for the impact on the *power system frequency* of potential *power system* disruptions ranging from the *critical single credible contingency event* to the most serious *contingency events*.

(e) *Western Power* must use its reasonable endeavours to ensure that adequate *facilities* are available and are under the *direction* of *Western Power* to allow the managed recovery of the *satisfactory operating state* of the *power system*.

5.5 CONTROL OF *NETWORK VOLTAGES*

5.5.1 *Transmission and Distribution Network Voltage* Control

(a) *Western Power* must determine the adequacy of the capacity to produce or absorb *reactive power* in the control of the *transmission and distribution network voltages*.

(b) *Western Power* must assess and determine the limits of the operation of the *transmission and distribution network* associated with the avoidance of *voltage* failure or collapse under *credible contingency event* scenarios.

(c) The determination referred to in clause 5.5.1(b) must include a review of the voltage stability of the *transmission network*.

(d) The limits of operation of the *transmission network* must be translated by *Western Power,* 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 *Western Power* in the maintenance of *power system security*.

(e) *Western Power* must use its reasonable endeavours to maintain *voltage* conditions throughout the *transmission and distribution network* in accordance with the technical requirements specified in Section 2.

(f) *Western Power* must use its reasonable endeavours to 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;* or under their *access contracts*;

(3) provision of such *facilities* by *Western Power*.

(g) Without limitation, such *reactive power facilities* may include:

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

(2) *synchronous condensers* (compensators);

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

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

(5) *shunt capacitors*;

(6) *shunt reactors*;

(7) series capacitors.

5.5.2 Reactive Power Reserve Requirements

(a) *Western Power* must use its reasonable endeavours to ensure that sufficient *reactive power reserve* is available at all times to maintain or restore the *power system* to a *satisfactory operating state* after the most *critical contingency event* as determined by previous analysis or by periodic contingency analysis by *Western Power*.

(b) If *voltages* are outside acceptable limits, and the means of *voltage* control set out in this clause 5.5 are exhausted, *Western Power* must take all reasonable actions, including to direct *changes* to demand (through selective *load shedding* from the *power system*), additional *generation* operation or reduction in the *transmission/distribution line* flows but only to the extent necessary to restore the *voltages* to within the relevant limits. A *User* must comply with any such *direction*.

5.5.3 Audit and Testing

Western Power must arrange, co-ordinate 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* under both *satisfactory operating state* and *contingency event* conditions.

5.6 *PROTECTION* OF *POWER SYSTEM* EQUIPMENT

5.6.1 *Power System* Fault Levels

(a) *Western Power* must determine the fault levels at all *busbars* of the *Western Power transmission network* as described in clause 5.6.1(b)*;*

(b) *Western Power* must ensure that there is information available about the *transmission* and *distribution network* which will allow the determination of fault levels for normal operation of the *power system. Western Power* will make available on request the *credible contingency events* which *Western Power* considers may affect the configuration of the *power system* so that *Western Power* and *Users* can identify their *busbars* which could potentially be exposed to a fault level which exceeds the fault current ratings of the circuit breakers and other equipment associated with that *busbar*.

5.6.2 *Power System Protection* Co-ordination

Western Power must use its reasonable endeavours to co-ordinate the *protection* settings for equipment connected to the *transmission and distribution network*. *Users* with *protection* systems that impact *power system security* and *reliability* must ensure their settings co-ordinate with *Western Power*'s *protection*. Such *Users* must provide their protection data to Western Power. Such *Users* may not adjust settings without *Western Power*'s approval. Specific requirements are described in clauses 3.4.2.15 and 4.2.3.

5.6.3 Audit and Testing

Western Power must use its reasonable endeavours to co-ordinate such inspections and tests as *Western Power* thinks appropriate to ensure that the *protection* of the *transmission* and *distribution network* is adequate to protect against damage to *power system plant* and equipment. Such tests must be performed according to the requirements of clause 4.1.

5.6.4 Short-Term Thermal Ratings of *Power System*

(a) *Western Power* may act so as to use, or require or recommend actions which use the full extent of the thermal ratings of *transmission* and *distribution elements* to maintain *power system security*, including the short-term ratings (being time dependent ratings), as defined by *Western Power* from time to time.

(b) *Western Power* must use its reasonable endeavours not to exceed the *transmission* and *distribution element* ratings and not to require or recommend action which causes those ratings to be exceeded.

5.6.5 Partial *Outage* of Power *Protection* Systems

(a) Where there is an *outage* of one *protection* of a *transmission element*, *Western Power* must determine, the most appropriate action. 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 installation of a temporary *protection*;

(4) to accept a degraded performance from the *protection*, with or without additional operational measures or temporary *protection* 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 *Western Power* determines this to be an unacceptable risk to *power system security*, *Western Power* must take the *transmission element* out of service as soon as possible and advise any affected *Users* immediately this action is undertaken.

(c) Any affected *User* must accept a determination made by *Western Power* under this clause 5.6.5.

5.7 *POWER SYSTEM* STABILITY CO-ORDINATION

5.7.1 Stability Analysis Co-ordination

(a) *Western Power* must use its reasonable endeavours to ensure that all necessary calculations associated with the stable operation of the *power system* as described in clause 2.3 and for the determination of settings of equipment used to maintain that stability are carried out and to co-ordinate these calculations and determinations.

(b) *Western Power* must facilitate establishment of the parameters and endorse the installation of *power system* devices which are approved by *Western Power* to be necessary to assist the stable operation of the *power system* .

5.7.2 Audit and Testing

Western Power must arrange, co-ordinate and supervise the conduct of such inspections and tests as it deems appropriate to assess the availability and adequacy of the devices installed to maintain *power system* stability.

5.8 POWER SYSTEM SECURITY OPERATIONS

5.8.1 *Users*' Advice

A *User* must promptly advise *Western Power* at the time that the *User* becomes aware of any circumstance which could be expected to adversely affect the secure operation of the *power system* or any equipment owned or under the control of the *User*.

5.8.2 *Protection* or Control System Abnormality

(a) If a *User* becomes aware that any relevant *protection* or *control system* is defective or unavailable for service, that *User* must advise *Western Power*. If *Western Power* considers it to be a threat to *power system security*, *Western Power* may direct that the equipment protected or operated by the relevant *protection* or *control system* be taken out of operation or operated as *Western Power* directs.

(b) A *User* must comply with a *direction* given by *Western Power* under clause 5.8.3(a).

5.8.3 *Western Power's* Advice on *Power System* Emergency Conditions

(a) *Western Power* must advise affected or potentially affected *Users* of all relevant details promptly after *Western Power* becomes aware of any circumstance with respect to the *power system* which, in the reasonable opinion of *Western Power,* could be expected to materially adversely affect *supply* to or from *Users*.

(b) Without limitation, such circumstances may include:

(1) electricity capacity shortfall, being a condition where there is insufficient *generation* or *supply* options available to enable the secure *supply* of the total *load* in a *region*;

(2) unexpected disruption of *power system security*, which may occur when:

(i) an unanticipated major *power system contingency event* occurs; or

(ii) significant environmental or similar conditions, including weather, storms or fires, are likely to, or are affecting the *power system*; or

(3) *black system* condition.

5.8.4 Managing a *Power System* Contingency Event

(a) During the period when the *power system* is affected by a *contingency event Western Power* must carry out actions, in accordance with the guidelines set out in these *Rules:*

(1) identify the impact of the *contingency event* on *power system security* in terms of the capability of the *transmission network*;

(2) identify and implement the actions required in each affected *region* to restore the *power system* to its *satisfactory operating state*.

(b) When *contingency events* lead to potential or actual electricity *supply* shortfall events, *Western Power* must follow the procedures outlined in clause 5.8.

5.8.5 Managing Electricity Supply Shortfall Events

(a) If, at any time, there are insufficient *transmission or distribution supply* options available to securely *supply* total *load* in a *region*, then, *Western Power* may undertake all or any of the following:

(1) recall of *transmission* and *distribution* equipment *outages*;

(2) *disconnect* one or more points of *load connection* as *Western Power* considers necessary;

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

(b) A *User* must use all reasonable endeavours to comply with a notice given under clause 5.8.5 (a)(3).

(c) If there is a major *supply* shortfall, *Western Power* must implement, to the extent practicable, a sharing of *load shedding* across *interconnected region*s up to the *power transfer capability* of the *network*.

5.8.6 *Direction*s by *Western Power* Affecting *Power System Security*

(NOTE: This clause is in accordance with previous regulation 30 of the Transmission *Regulations and previous regulation 32 of the Distribution Regulations, and is unclear where these powers reside in the new legislative framework This note to be deleted in the final document.)*

Subject to *Western Power* giving a *User* a reasonable period of time to take appropriate action:

(a) *Western Power* may give reasonable *direction*s to any *User*:

(1) requiring the *User* to do any act or thing which *Western Power* considers reasonably necessary to ensure, to maintain or re-establish the *power system* in a *satisfactory operating state*, including but not limited to:

(i) establish or remove a connection;
(ii) disconnect a connection;
(iii) switch off a generator;
(iv) call plant or equipment into service;
(v) commence operation od any plant or equipment or maintain, increase or reduce generation or absorption of active or reactive power output by any plant or equipment;
(vi) shut down or vary operation of any plant or equipment;
(vii) shed or restore load, or;
(viii) do any other act or thing necessary to be done;

or

(2) for or with respect to, reasonable standards and procedures to be observed by the *User*:

(i) to achieve *power system security* in any region or, where there may be risk to equipment forming part of the *power system,* security of equipment, any other person; or
(ii) to maintain *voltage* levels or *reactive power reserves* through the part of the *power system* in a *region*

(3) A direction under subclauses (1) or (2) must specify the period within which the direction must be complied with and for how long the direction must be complied with.

(4) A direction under subclauses (1) or (2) must be recorded by Western Power

(5) If a person (in this document called the “first person”) is directed to do something under subclauses (1) or (2) but does not comply with the direction, then Western Power may authorise a Western Power employee or another person to carry out that direction and the first person must do all such things as the first person is requested by the authorised person to do in order to assist the authorised person to carry out that direction.

(b) A *User* must use all reasonable endeavours to comply within a reasonable period of time with any such *direction*s given to it by *Western Power*. If a *User* does not comply with a *direction* within a reasonable period of time and as such a *satisfactory operating state* cannot be re-established, *Western Power* may *disconnect* the *User* without further recourse.

5.8.7 *Disconnection* of Generating Units and/or *Associated Loads*

(a) Where, under the *Access Code* or these Rules*, Western Power* has the authority or responsibility to *disconnect* either a *generating unit* or its *associated load*, then it may do so (either directly or through any agent) as described in clause 4.3.

(b) The relevant *User and associated load* must provide all reasonable assistance to *Western Power* for the purpose of such *disconnection*.

5.8.8 Emergency Black Start-up *Facilities*

Users, other than non-dispatchable generators, such as wind generators, must ensure they have sufficient *facilities* available and operable, or make alternative arrangements, for their own black start-up requirements.

5.8.9 Local Black System Procedures

(a) *User, other than non-dispatchable generators,* must develop the draft *black system procedures* for each of its *power stations* and must submit those procedures for approval by *Western Power*.

(b) *Western Power* may request amendments to a *User*'s draft *black system procedures* or any proposed changes as *Western Power* reasonably considers necessary by notice in writing to the *User,* where use is to be made of the *transmission network.*

(c) If *Western Power* and a *User* are unable to agree on the amendments, the matter may be dealt with under the Dispute Resolution Section of the *Access Code (Chapter 10* and *Appendix 5).*

5.8.10 Black System Start-up

(a) *Western Power* must advise a *User* if, in *Western Power*'s reasonable opinion, there is a *black system* condition which is affecting, or which may affect, that *User*.

(b) If a *User* is providing *black start-up facilities* under an *agreement* with another *User*, then the *local black system procedures* for that *User* must be consistent with these *Rules* and their *access contracts*.

(c) *Western Power* may by notice in writing to the relevant *User* require such amendments to the *local black system procedures* for a *User* which, in its reasonable opinion, are needed for consistency with:
(1) actual *power system* requirements; or
(2) if the *User* is providing *black start-up facilities* to another *User* under an *agreement*, the relevant connection *contract or Access Code.*

(d) If *Western Power* advises a *User* of a *black system* condition, and/or if the terms of the relevant *local black system procedures* require the *User* to take action, then the *User* must comply with the agreed requirements of the *local black system procedures*.

(e) If there is a *black system* condition, then a *User/Customer* must comply with *Western Power's* instructions with respect to the timing and magnitude of *load* restoration, as well as subsequent *load* movements or *disconnection*s.

5.8.11 Review of Operating Incidents

(a) *Western Power* must conduct reviews of significant operating incidents or deviations from normal operating conditions in order to assess the adequacy of the provision and response of *facilities* or services, and the appropriateness of actions taken to restore or maintain *power system security*.

(b) For all cases where *Western Power* has been responsible for the *disconnection* of a transmission *User*, a report of the review carried out must be provided by *Western Power* to the *User* advising of the circumstances requiring that action. This generally does not apply to distribution system, due to the large number of customers.

(c) A *User* must co-operate in any such review conducted by *Western Power* (including making available relevant records and information).

(d) A *User* must provide to *Western Power* such information relating to the performance of its equipment during and after particular *power system* incidents or operating condition deviations as *Western Power* reasonably requires for the purposes of analysing or reporting on those *power system* incidents or operating condition deviations.

(e) *Western Power* must provide to a *User* such information or reports relating to the performance of that *User's* equipment during *power system* incidents or operating condition deviations as that *User* reasonably requests and in relation to which *Western Power* is required to conduct a review under this clause.

5.9 *POWER SYSTEM SECURITY* RELATED MARKET OPERATIONS

5.9.1 Dispatch Related Limitations on Generators

A *Scheduled Generator* must not, unless in the *Scheduled Generator's* reasonable opinion public safety would otherwise be threatened or there would be a material risk of damaging equipment or the environment:

(a) *dispatch* any *energy* from a *scheduled generating unit*, except:
   (1) in accordance with the procedures specified in these *Rules* and its Technical Requirements for connection; or
   (2) in accordance with an instruction from *Western Power*; or
   (3) as a consequence of operation of the *generating unit's* automatic *load* following scheme approved by *Western Power*; or
   (4) in accordance with a procedure agreed with *Western Power*; or
   (5) in connection with a test conducted in accordance with the requirements of these *Rules* or a procedure agreed with by *Western Power*;

(b) adjust the *transformer tap position* or *excitation control system voltage* set-point of a *scheduled generating unit* except:
   (1) in accordance with an instruction from or by agreement with *Western Power*; or
   (2) in response to remote control signals given by *Western Power* or its agent; or

(3) if, in the scheduled *generator's* reasonable opinion, the adjustment is urgently required to prevent material damage to the *scheduled generator's plant* or associated equipment, or in the interests of safety; or

(4) in connection with a test agreed with *Western Power* and conducted in accordance with these *Rules* or procedures agreed with *Western Power*.

(c) *energise* a *connection point* in relation to a *scheduled generating unit* without prior approval from *Western Power*. This approval must be obtained immediately prior to *energisation*;

(d) *synchronise* a *scheduled generating unit* to, or *de-synchronise* a *scheduled generating unit* from, the *power system* without prior approval from *Western Power* except *de-synchronisation* as a consequence of the operation of automatic *protection* equipment or where such action is urgently required to prevent material damage to *plant* or equipment or in the interests of safety;

(e) change the *frequency response mode* of a *scheduled generating unit* without the prior approval of *Western Power*; or

(f) remove from service or interfere with the operation of any *power system* stabilising equipment installed on that *generating unit*.

5.9.2 Commitment of Generating Units

In relation to any *User's generating unit,* the *User* must confirm with *Western Power*, the expected *synchronising* time at least one hour before the expected actual *synchronising* time, and update this advice 5 minutes before *synchronising* unless otherwise agreed with *Western Power*. *Western Power* may require further notification immediately before *synchronisation*.

5.9.3 De-commitment or Output Reduction by Generators

(a) Any *Scheduled Generator* intending to reduce output or de-commit own generation must notify *Western Power* well in advance. To do this a *User* will have to both apply for it and include it in the *outage* and production plans they submit to *Western Power* in accordance with clause A3.56 of the *Access Code, as is outlined in* clause 5.9.5 here.

(b) A *scheduled generator* must confirm with *Western Power* the expected *de-synchronising* time at least one hour before the expected actual *de-synchronising* time, and update this advice 5 minutes before *de-synchronising* unless otherwise agreed with *Western Power*. *Western Power* may require further notification immediately before *de-synchronisation*.

(c) Information to be confirmed with *Western Power* to *de-commit* a *generating unit* if there is to be no automatic and coincident reduction in the *User's associated load* must include:

(1) the time to commence decreasing the output of the *generating unit*;

(2) the *ramp rate* to decrease the output of the *generating unit*;

(3) the time to *de-synchronise* the *generating unit*; and

(4) the output from which the *generating unit* is to be *de-synchronised*.

(d) Any *User* who wishes to take a *generator* out-of-service must first reduce the *associated load* demand by an amount equal to the *generator* output to be reduced. Once the demand has been reduced, the *generator*'s *load* may be reduced. Clearance must be obtained from *Western Power* before commencing this exercise.

5.9.4 Generation *Plant* Changes

A *User* must, without delay, notify *Western Power* of any event which has changed or is likely to change the operational availability or *load* following capability of any of its *generating units*, whether the relevant *generating unit* is *synchronised* or not, as soon as the *User* becomes aware of the event.

5.9.5 Operation, Maintenance and Extension Planning

In accordance with clause A3.56 of the *Access Code* for coordination purposes, operation, maintenance and extension planning and co-ordination shall be performed as follows:

(1) On or before 1 July and 1 January each year, each user must provide to Western Power:

  (a) a maintenance schedule in respect of the plant and equipment connected at each of its connections for the following financial year; and

  (b) a non-binding indicative planned maintenance plan in respect of the plant and equipment connected at each of its connections for each of the 2 financial years following the financial year to which the maintenance schedule provided under paragraph (a) relates.

(2) A User must provide Western Power with any information that Western Power reasonably requests considering maintenance of plant and equipment connected at the User's connections.

(3) A User must ensure that a maintenance schedule provided by the User under clause (1) is complied with, unless otherwise agreed with Western Power.

(4) A maintenance schedule or a maintenance plan must:

  (a) specify the dates and duration of planned outages for the relevant plant or equipment which may have an impact on the electricity transmission network;

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

  (c) be in writing in substantially the form requested by Western Power; and

  (d) be consistent with good electricity industry practice.

(5) If a User becomes aware that a maintenance plan provided by the User under subclause (1) in respect of one of its connections will not be complied with, then the User must promptly notify Western Power.

5.10 *POWER SYSTEM* OPERATING PROCEDURES

5.10.1 *Power System* Operating Procedures

The *power system operating procedures* are:

(1) any instructions which may be issued by *Western Power* from time to time relating to the operation of the *power system*; and

(2) any guidelines issued from time to time by *Western Power* in relation to *power system security*.

5.10.2 *Transmission and Distribution Network* Operations

(a) *Western Power* must conduct or direct operations on the *transmission and distribution network* in accordance with the appropriate *power system operating procedures and good electricity industry practice*.

(b) A *User* must observe the requirements of the relevant *power system operating procedures*.

(c) *Users* must operate their equipment interfacing with the *transmission and distribution network* in accordance with the requirements of the *Access Code*, these *Rules*, any applicable *access contract*, *agreement,* and *Western Power*'s Electrical Safety Instructions and procedures.

(d) *Users* must ensure that *transmission distribution network* operations performed on their behalf are undertaken by competent persons.

5.10.3 Switching of Reactive Power *Facilities*

(a) *Western Power* may instruct a *User* to place reactive *facilities* belonging to or controlled by that *User* into or out of service for the purposes of maintaining *power system security* where prior arrangements concerning these matters have been made between *Western Power* and a *User*.

(b) Without limitation to its obligations under such prior arrangements, a *User* must use reasonable endeavours to comply with such an instruction given by *Western Power* or its authorised agent.

5.11 *POWER SYSTEM SECURITY* SUPPORT

5.11.1 Remote Control and Monitoring Devices

(a) All remote control, operational *metering* and monitoring devices and local circuits as described in Section 3, must be installed and maintained by a *User* in accordance with the standards and protocols determined and advised by *Western Power* (for use in the *Western Power control centre*) for each:

(1) *generating unit* and *associated load connected* to the *transmission or distribution network*;

(2) *substation connected* to the *network*; and

(3) *ancillary service* provided by that *User.*

(b) The provider of any *ancillary services* must arrange the installation and maintenance of all *remote control equipment* and *remote monitoring equipment* in accordance with the standards and protocols determined by *Western Power* for use in the *Western Power control centre*.

(c) The controls and monitoring devices must include the provision for indication of *active power* and *reactive power* output, and to signal the status and any associated alarm condition relevant to achieving adequate *protection* control and indication of the *transmission network*, and the *User's plant* active and reactive output consumption.

5.11.2 Operational Control and Indication Communication *Facilities*

(a) In accordance with clauses 3.2.5.1, 3.2.5.2, 3.3.8.1 and 3.3.8.2, as applicable, each *User* must provide and maintain the necessary primary and, where nominated by *Western Power*, back-up communications *facilities* for control, operational *metering* and indication from the relevant local sites to the appropriate interfacing termination as nominated by *Western Power*.

5.11.3 *Power System* Voice/Data Operational Communication *Facilities*

(a) *Users* must advise *Western Power* of each nominated position for the purposes of giving or receiving *operational communications* in relation to each of its *facilities*. The position so nominated must be that responsible for undertaking the operation of the relevant equipment of the relevant *User*.

(b) Contact personnel details which must be forwarded to *Western Power* include:
   (1) 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*.

(c) Each *User* must provide, for each nominated position, two independent telephone communication systems fully compatible with the equipment installed at the appropriate *control centre* nominated by *Western Power*.

(d) Each *User* must maintain both telephone communication systems in good repair and must investigate faults within 4 hours, or as otherwise agreed with *Western Power*, of a fault being identified and must repair or procure the repair of faults promptly.

(e) Each *User* must establish and maintain a form of electronic mail facility as approved by *Western Power* for communication purposes (such approval may not be unreasonably withheld).

(f) *Western Power* must advise all *Users* of nominated persons for the purposes of giving or receiving *operational communications*.

(g) Contact personnel details to be provided by *Western Power* include title, telephone numbers, a facsimile number and an electronic mail address for the contact person.

5.11.4 Records of *Power System* Operational Communication

(a) *Western Power* and *Users* must record each telephone *operational communication* in the form of log book entries or by another auditable method which provides a permanent record as soon as practicable after making or receiving the *operational communication*.

(b) Records of *operational communications* must include the time and content of each communication and must identify the parties to each communication.

(c) Voice recordings of telephone *operational communications* may be undertaken by *Western Power* and *Users*. *Western Power* and the *User* must ensure that when a telephone conversation is being recorded under this clause, the persons having the conversation receive an audible indication that the conversation is being recorded in accordance with relevant statutory requirements. Voice recordings may be used as an alternative to written logs.

(d) *Western Power* and *Users* must retain all *operational communications* records including voice recordings for a minimum of 7 years.

(e) In the event of a dispute involving an *operational communication*, the records of that *operational communication* maintained by, or on behalf of *Western Power* will constitute prima facie evidence of the contents of the *operational communication*.

5.11.5 Agent Communications

(a) A *User* may appoint an agent (called a "*User Agent*") to coordinate operations of one or more of its *facilities* on its behalf, but only with the prior written consent of *Western Power*.

(b) A *User* which has appointed a *User Agent* may replace that *User Agent* but only with the prior written advice to *Western Power*.

(c) *Western Power* may only withhold its consent to the appointment of a *User Agent* under clause 5.11.5(a), if it reasonably believes that the relevant person is not suitably qualified or experienced to operate the relevant *facility* at the interface with a *transmission or distribution network*.

(d) For the purposes of the *Access Code* and these *Rules*, acts or omissions of a *User Agent* are deemed to be acts or omissions of the relevant *User*.

(e) *Western Power* and its *representatives* (including authorised agents) may:

  (1) rely upon any communications given by a *User Agent* as being given by the relevant *User*; and

  (2) rely upon any communications given to a *User Agent* as having been given to the relevant *User*.

(f) *Western Power* is not required to consider whether any instruction has been given to a *User Agent* by the relevant *User* or the terms of those instructions.

5.12 NOMENCLATURE STANDARDS

(a) A *User* must use the *nomenclature standards* for *transmission* and *distribution* equipment and apparatus as agreed with *Western Power* or failing agreement, as determined by *Western Power*.

(b) A *User* must use reasonable endeavours to ensure that its *representatives* comply with the *nomenclature standards* in any *operational communications* with *Western Power*.

(c) A *User* must ensure that name plates on its equipment relevant to operations at any point within the *power system* conform to the requirements set out in the *nomenclature standards*.

(d) A *User* must use reasonable endeavours to ensure that nameplates on its equipment relevant to operations within the *power system* are maintained to ensure easy and accurate identification of equipment.

(e) A *User* must ensure that technical drawings and documentation provided to *Western Power* comply with the *nomenclature standards*.

(f) Western Power may, by notice in writing, request a User to change the existing numbering or nomenclature of transmission and distribution equipment and apparatus of the User for purposes of uniformity, and the User must comply with such request provided that if the existing numbering or nomenclature conforms with the nomenclature standards.

6. DEROGATIONS

6.1 PURPOSE AND APPLICATION

(a) This Section prevails over all other Sections of these *Rules*.

(b) *Derogations* of *Users* are:

(1) those provisions of the other Sections of the *Rules* which shall not apply either in whole or part to particular *Users* or potential *Users* or others in relation to their *facilities* for a fixed or indeterminate period;

(2) any provisions which substitute for those provisions which are not to apply; and

(3) applicable only to that particular *User* or potential *User*.

(c) *Derogations* are for the purpose of:

(1) enabling *Users* to effect an orderly transition to the provisions of the *Rules* from those provisions currently applying;

(2) providing specific exemptions from the *Rules* for pre-existing arrangements *which Western Power* determines must continue beyond a specific transition period; and

(3) providing specific exemptions from the *Rules* for future arrangements which *Western Power* determines to be acceptable.

(d) Applications for *derogations* must be submitted to and processed by *Western Power* in accordance with clauses 12.33 to 12.39 of the *Access Code*.

6.2 TRANSMISSION AND DISTRIBUTION NETWORKS AND FACILITIES EXISTING AT DD MONTH 2006

All *plant* and equipment in the *South West Interconnected System*, and all *facilities* connected to these *networks* existing at **DD MONTH 2006** are deemed to comply with the requirements of these *Rules*. If at any time it is found that an installation is adversely affecting *power system security*, *reliability* of the *power system* and/or the *quality of supply*, the relevant *User* shall be responsible for remedying the problem.

ATTACHMENT 1

GLOSSARY

In these *Rules*, unless the contrary intention appears:

(a) a word or phrase set out in column 1 of the table below has the meaning set out opposite that word or phrase in column 2 of the table below; and

(b) a word or phrase defined in the Electricity Industry Act 2004 ("*Act*") and Electricity Networks Access Code 2004 ("*Access Code*") has the meaning given in that *Act* or that *Code* (as the case requires), unless redefined in the table below.

access contract	Has the meaning given in the *Act*.
access application	Has the meaning given in the *Access Code*.
access services	Has the same meaning as "covered service" in the *Access Code*.
active energy	A measure of electrical energy flow, being the time integral of the product of *voltage* and the in-phase component of current flow across a *connection* point, expressed in Watthours (Wh) and multiples thereof.
active power	The rate at which *active energy* is transferred.
active power capability	The maximum rate at which *active energy* may be transferred from a *generating unit* to a *connection point* as specified in an *access contract*.
agreed capability	In relation to a *connection point,* the capability to receive or send out *active power* and *reactive power* for that *connection point* determined in accordance with the relevant *access contract*.
ancillary services	Has the same meaning as "covered service (e)" in the *Access Code*.
	.
associated load	A *load* which is normally supplied by a particular *generator* and is associated with that *generator* by ownership or some contractual arrangement. The *load* may be remote from the *generator* or on-site.
augment, augmentation	Has the meaning given in the *Access Code*.
Australian Standard (AS)	The most recent edition of a standard publication by Standards Australia (Standards Association of Australia).
automatic reclose equipment	In relation to a *transmission line*, the equipment which automatically recloses the relevant line's circuit breaker(s) following their opening as a result of the detection of a fault in the *transmission line*.
back up protection	A *protection* intended to supplement the main *protection* in case the latter should be ineffective, or to deal with faults in those parts of the *power system* that are not readily included in the operating zone of the main *protection*.

black start capability	In relation to a *generating unit*, the ability to start and *synchronise* without using supply from the *power system*.
black start-up facilities	The *facilities* required to provide a *generating unit* with *black start-up capability*.
black system	The absence of *voltage* on all or a significant part of the *transmission network* following a major *supply* disruption, affecting one or more *power stations* and a significant number of customers.
breaker fail	In relation to a *protection scheme*, that part of the *protection scheme* that protects a *User's facilities* against the non-operation of a circuit breaker that is required to open.
busbar	A common *connection point* in a *power station substation* or a *transmission* or *distribution network substation*.
business day	Has the meaning given in the *Access Code*.
capacitor bank	A type of electrical equipment used to generate *reactive power* and therefore support *voltage* levels on *transmission* or *distribution lines*.
cascading outage	The occurrence of an uncontrollable succession of *outages*, each of which is initiated by conditions (e.g. instability or overloading) arising or made worse as a result of the event preceding it.
change	Includes amendment, alteration, addition or deletion.
circuit breaker failure	A circuit breaker will be deemed to have failed if, having received a trip signal from a *protection scheme*, it fails to interrupt fault current within its design operating time.
Rules, Technical Rules	These *Rules* called the *Technical Rules* prepared by *Western Power* under clause 4.1 of the *Access Code*.
Rules commencement date	The date given in clause 1.3 of these *Rules*.
commitment	The commencement of the process of starting up and *synchronising* a *generating unit* to the *power system*.
complementary	In relation to *protection*, two *protection schemes* are said to be complementary when, in combination, they provide dependable clearance of faults on *plant* within a specified time, but with any single failure to operate of the *secondary plant*, fault clearance may be delayed until the nature of the fault changes.
connect, connected	To form a physical link to or through the *transmission or distribution network*, by direct or indirect connection, so as to have an impact on *power system security, reliability* and *quality of supply*.
connection	The physical link between a *User* and Western Power (via a *connection asset*) that allows the transfer of electricity from one to the other.

connection contract	Has the same meaning as "connection service contract" in the *Access Code*.
connection asset	The electrical equipment that allows the transfer of electricity between the electricity transmission or distribution network and an electrical system that is not part of that network. This includes any transformers or switchgear at the point of interconnection (including those that operate at a nominal voltage of less than 66kV) but does not include the lines and switchgear at the connection that form part of the electricity transmission or distribution network.
connection point	The agreed point of *supply* established between *Western Power* and a *User*.
constraint, constrained	A limitation on the capability of a *network, load* or a *generating unit* preventing it from either transferring, consuming or generating the level of electrical power which would otherwise be available if the limitation was removed.
contingency capacity reserve	Actual *active* and *reactive energy* capacity, *interruptible load* arrangements and other arrangements organised to be available to be utilised on the actual occurrence of one or more *contingency events* to allow the restoration and maintenance of *power system security.*
contingency event	An event affecting the *power system* which *Western Power* 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 *Western Power* for directing the minute to minute operation of the *power system*.
controller	Has the same meaning as "designated controller" in Appendix 3 of the *Access Code*.
control system	Means of monitoring and controlling the operation of the *power system* or equipment including *generating units connected* to a *transmission* or *distribution*.
converter coupled generating unit	A generator uses a machine, device, or system that changes its alternating-current power to alternating-current power acceptable for power system connection.
credible contingency event	A *contingency event* the occurrence of which *Western Power* considers to be reasonably possible in the surrounding circumstances. This will include events such as the disconnection of any single generating unit or transmission or distribution line with or without the application of a fault.
critical fault clearance time	Refers to the maximum *total fault clearance time* that the *power system* can withstand without one or both of the following conditions arising: 1. Instability (refer to clause 2.3); and 2. Unacceptable disturbance of *power system voltage* or *frequency*.

critical credible contingency event	A *critical credible contingency event* considered by *Western Power*, in the particular circumstances, is an event that has potential for the most significant impact on the *power system* at that time. This would generally be the instantaneous loss of the largest *generating unit* or a fault on a *transmission element* on the *power system*. However, this may involve the consideration by *Western Power* of the impact of the loss of any *interconnection* under abnormal conditions.
current rating	The maximum current that may be permitted to flow (under defined conditions) through a *transmission* or *distribution line* or other item of equipment that forms part of a *power system.*
current transformer (CT)	A *transformer* for use with *meters* and/or protection devices in which the current in the secondary winding is, within prescribed error limits, proportional to and in phase with the current in the primary winding.
Customer	A person who engages in the activity of purchasing electricity *supplied* through a *transmission* or *distribution network*.
day	Unless otherwise specified, the 24 hour period beginning and ending at midnight Western Standard Time (WST).
decommission, decommit	In respect of a *generating unit*, ceasing to generate and *disconnecting* from a *network*.
derogation	Modification, variation or exemption to one or more provisions of the *Rules* in relation to a *User* according to Section 6.
de-synchronising/ de-synchronisation	The act of *disconnection* of a *generating unit* from the *power system*, normally under controlled circumstances.
differing principle	Two *protections* are said to be of *differing principle* when their functioning is based on different measurement or operating methods, or use similar principles but have been designed and manufactured by different organisations.
direction	A direction issued by *Western Power* to any *User* requiring the *User* to do any act or thing which *Western Power* 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*.
disconnection, disconnect	The operation of switching equipment or other action so as to prevent the flow of electricity at a *connection point*.
dispatchable generating unit	A generator that in its satisfactory normal operating state is capable of closely controlling its real power output
dispatch	The act of committing to service all or part of the generation available from a *scheduled generating unit*.
distribution network	Has the same meaning as 'distribution system' in the *Act*.

dynamic performance	The response and behaviour of *networks* and *facilities* which are *connected* to the *networks* when the *satisfactory operating state* of the *power system* is disturbed.
electrical energy loss	*Energy* loss incurred in the production, transportation and/or use of electricity.
Electricity Referee	Has the meaning given in the Dispute Resolution section of the *Access Code* (Chapter 10 and Appendix 5)
electricity transmission capacity	Has the same meaning as "capacity" in Appendix 3 of the *Access Code,* when it is applied to a transmission system.
electricity transmission network, network, transmission network	All have the same meaning as "transmission system" in the *Act*.
embedded generator	A *generator* which supplies on-site *loads* or *distribution network loads* and is *connected* either indirectly (ie. via the *distribution network*) or directly to the *transmission network*.
energise/energisation	The act of operation of switching equipment or the start-up of a *generating unit*, which results in there being a non-zero *voltage* beyond a *connection point* or part of the *transmission / distribution network*.
energy	*Active energy* and/or *reactive energy*.
energy data	The data that results from the measurement of the flow of electricity in a power conductor. The measurement is carried out at a *metering point.*
excitation control system	In relation to a *generating unit,* the automatic *control system* that provides the field excitation for the generator of the *generating unit* (including excitation limiting devices and any power system stabiliser).
extension	An *augmentation* that requires the *connection* of a power line or *facility* to the *transmission* or *distribution network.*
facility	A generic term associated with the apparatus, equipment, buildings and necessary associated supporting resources provided at, typically: (a) a *power station* or *generating unit*, including *black start-up facilities*; (b) a *substation* or *power station substation*; (c) a *control centre*.
fault clearance time	The time interval between the occurrence of a fault and the fault clearance.
financial year	A period commencing on 1 July in one calendar year and terminating on 30 June in the following calendar year.
frequency	For alternating current electricity, the number of cycles occurring in each second. The term Hertz (Hz) corresponds to cycles per second.

frequency operating standards	The standards which specify the frequency levels for the operation of the *power system* set out clause 2.2.
frequency response mode	The mode of operation of a *generating unit* which allows automatic change*s* to the generated power when the *frequency* of the *power system* changes.
generated	In relation to a *generating unit,* the amount of electricity produced by the *generating unit* as measured at its terminals.
generating plant	In relation to a *connection point*, includes all equipment involved in generating electrical *energy*.
generating system	A system comprising one or more *generating units.*
generating unit	The actual generator of electricity and all the related equipment essential to its functioning as a single entity including step-up *transformer connecting* it to the *power system*, and includes *embedded generators*.
generation	The production of electrical power by converting another form of *energy* in a *generating unit.*
generation centre	A geographically concentrated area containing a *generating unit* or *generating units* with significant combined generating capability.
Generator	A person who engages in the activity of owning, controlling, or operating a *generating system* that *supplies* electricity to, or who otherwise *supplies* electricity to, a *transmission network* or *distribution network*.
good electricity industry practice	Has the meaning given in the *Access Code*.
governor system	The automatic *control system* which regulates the speed and power output of a *generating unit* through the control of the rate of entry of the primary *energy* input (for example, steam, gas or water) into the *generating unit*. New terminology is turbine control system.
Induction generating unit	The alternating current generator-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. It employs a conventional induction machine.
Doubly fed induction generating unit	A special wound rotor design of the induction machine, which is effectively a combination of the converter coupled generating unit (rotor side) and conventional induction generating unit (stator side).
instrument transformer	Either a *current transformer* (*CT*) or a voltage transformer (*VT*).
interconnection, interconnector, interconnect, interconnected	A *transmission line* or group of *transmission lines* that connects the *transmission networks* in adjacent *regions*.

interruptible load	A *load* which is able to be *disconnected*, either manually or automatically initiated, which is provided for the restoration or control of the *power system frequency* by *Western Power* to cater for *contingency events* or shortages of *supply*.
intra-regional	Within a *region*.
inverter coupled generating unit	A generator which uses a machine, device, or system that changes its direct-current power to alternating-current power acceptable for power system connection.
large disturbance	The disturbance is considered to be sufficiently large or severe if linearization of system equations in not permissible for the purposes of analysis. The resulting system response involves large excursions of system variables from their pre-disturbance values, and is influenced by non-linear power-angle relationship and other non-linearity effects in power systems. Large disturbance is typically caused by a short circuit on a nearby power system component (for example, transmission line, transformer, etc).
load	A *connection point* at which electrical power is delivered to a person or the amount of electrical power delivered at a defined instant at a *connection point*.
load centre	A geographically concentrated area containing *load* or *loads* with a significant combined consumption capability.
load shedding	Reducing or disconnecting *load* from the *power system*.
local black system procedures	The procedures, described under clause 5.8.9 applicable to a *User* as approved by *Western Power* from time to time.
maximum fault current	The current that will flow to a fault on an item of *plant* when *maximum system conditions* prevail.
maximum system conditions	For any particular location in the *power system*, *maximum system conditions* as those which will prevail with the maximum number of *generators* normally connected at times of maximum *generation*.
minimum fault current	The current that will flow to a fault on an item of *plant* when present day *minimum system conditions* prevail.
minimum system conditions	For any particular location in the *power system*, *minimum system conditions* as those which will prevail with the least number of *generators* normally connected at times of minimum *generation*, in combination with one *primary plant outage*. The *primary plant outage* shall be 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 *plant* for comparison with expected performance.

month	Unless otherwise specified, the period of beginning at 12.00 am on the "relevant commencement date" and ending at 12.00 am on the date in the "next calendar month" corresponding to the commencement date of the period. If the "relevant commencement date" is the 29th, 30th or 31st and this date does not exist in the "next calender month", then the end date in the "next calender month" shall be taken as the last day of that month.
nameplate rating	The maximum continuous output or consumption in MW or MVA of an item of equipment as specified by the manufacturer.
NATA	National Association of Testing Authorities.
network	See definition for *electricity transmission network*.
network capability	The capability of the *network* or part of the *network* to transfer electricity from one location to another.
network losses	*Energy* losses incurred in the transfer of electricity over a *transmission* or *distribution network*.
network planning criteria	The criteria prepared by *Western Power* under section A 6.1(m) of the *Access Code*.
new capacity	Any increase in electricity generation, transmission or distribution capacity which would arise from enhancement to or expansion of the electricity generation, transmission or distribution system.
nomenclature standards	The standards approved by *Western Power* relating to numbering, terminology and abbreviations used for information transfer between *Users* as provided for in clause 5.12.
non-credible contingency event	A *contingency event* other than a *credible contingency event*. It means a *contingency event* in relation to which, in the circumstances, the probability of occurrence is considered by *Western Power* to be very low.
Non-Dispatchable generating unit	A generator that in its satisfactory normal operating state is not capable of closely controlling its real power output.
normal operating frequency band	In relation to the *frequency* of the *power system*, means the range specified in clause 5.2.1(a).
normal operating frequency excursion band	In relation to the *frequency* of the *power system*, means the range specified as being acceptable for infrequent and momentary excursions of *frequency* outside the *normal operating frequency band* being the range specified in clause 5.2.1(a).
operational communication	A communication concerning the arrangements for, or actual operation of the *power system* in accordance with the *Rules*.
outage	Any planned or unplanned full or partial unavailability of plant or equipment.

peak load	Maximum *load*.
plant	Includes all equipment involved in generating, utilising or transmitting electrical *energy*.
power factor	The ratio of the *active power* to the apparent power at a point.
power station	In relation to a *Generator*, a *facility* in which any of that *Generator's generating units* are located.
power system	The electricity power system including associated *generation* and *transmission and distribution networks* for the *supply* of electricity, operated as an integrated arrangement.
power system operating procedures	The procedures to be followed by *Users* in carrying out operations and /or maintenance activities on or in relation to primary and *secondary equipment connected* to or forming part of the *power system* or *connection points,* as described in clause 5.10.1.
power system security	The safe scheduling, operation and control of the *power system* on a continuous basis in accordance with the principles set out in clause 5.2.4.
power transfer	The instantaneous rate at which *active energy* is transferred between *connection points*.
power transfer capability	The maximum permitted *power transfer* through a *transmission network* or part thereof.
primary plant	Refers to apparatus which conducts *power system load* or conveys *power system voltage*.
protection	Used to describe the concept of detecting, limiting and removing the effects of *primary plant* faults from the *power system*. Also used to refer to the apparatus 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	A collection of one or more sets of *protection* for the purpose of protecting *facilities* and the *electricity transmission* or *distribution network* from damage due to an electrical or mechanical fault or due to certain conditions of the *power system*.
protection system	A system which includes all the *protection schemes* applied to the system.
quality of supply	Has the meaning, with respect to electricity, technical attributes to a standard referred to in clause 2.2, unless otherwise stated in these *Rules* or an *access contract*.
ramp rate	The rate of *change* of electricity produced from a *generating unit*.

reactive energy	A measure, in varhours (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 plant	*Plant* which is normally specifically provided to be capable of providing or absorbing *reactive power* and includes the *plant* identified in clause 5.5.1(g).
reactive power	The rate at which *reactive energy* is transferred. *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 *plant* such as: (a) alternating current generators (b) capacitors, including the capacitive effect of parallel *transmission* wires; (c) *synchronous condensers.*
reactive power capability	The maximum rate at which *reactive energy* may be transferred from a *generating unit* to a *connection point* as specified in an *access contract*.
reactive power reserve	Unutilised sources of *reactive power* arranged to be available to cater for the possibility of the unavailability of another source of *reactive power* or increased requirements for *reactive power*.
reactive power support/reactive support	The provision of *reactive power*.
reactor	A device, similar to a *transformer.* Arranged to be *connected* into the *transmission or distribution 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, regional	An area determined by *Western Power*, being an area served by a particular part of the *transmission network* containing one or more major *load centres* or *generation centres* or both.
regulating duty	In relation to a *generating unit,* the duty to have its generated output adjusted frequently so that any *power system frequency* variations can be corrected.
reliability	The probability of a system, device, *plant* or equipment performing its function adequately for the period of *time* intended, under the operating conditions encountered.
reliable	The expression of a recognised degree of confidence in the certainty of an event or action occurring when expected.

remote back up protection	Refers to the detection and initiation of tripping at a location other than that at which the main *protection scheme* of the faulted *plant* is located. *Remote back up protection* provides a means of detecting and initiating clearance of *small zone faults* or fault contributions supplied via failed circuit breakers.
remote monitoring equipment (RME)	Equipment installed to enable monitoring of a *facility* from a *control centre*, including 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.
RTU	Means a Remote Terminal Unit installed within a substation to enable monitoring and control of a facility from a *control centre*.
satisfactory operating state	In relation to the *power system*, has the meaning given in clause 5.2.1.
SCADA system	Supervisory control and data acquisition equipment which enables *Western Power* to continuously and remotely monitor, and to a limited extent control, the import or export of electricity from or to the *power system*.
scheduled generating unit	A *generating unit* which is dispatched by *Western Power*.
secondary equipment, secondary plant	Those assets of a *facility* and the *electricity transmission* or *distribution network* which do not carry the *energy* being traded, but which are required for control, protection or operation of assets which carry such *energy*.
secondary plant contingency	Any single failure of *secondary plant*.
security	*Security* of a power system refers to the degree of risk in its ability to survive imminent disturbances (contingencies) without interruption of customer service. It relates to robustness of the system to imminent disturbances and, hence, depends on the system operating condition as well as the contingent probability of disturbances.
secure operating state	In relation to the *power system* has the meaning given in clause 5.2.2.
sensitivity	In relation to *protection schemes*, has the meaning in clause 3.4.2.6 for normal operating zones and the meaning in clause 3.4.2.9 for back up operating zones.
settlements	The activity of producing bills and credit notes for *Users*.
shunt capacitor	A type of *plant connected* to a *network* to generate *reactive power*.

shunt reactor	A type of *plant connected* to a *network* to absorb *reactive power*.
single contingency	In respect of a *transmission network*, a sequence of related events which result in the removal from service of one *transmission line*, *transformer* or other item of *plant*. The sequence of events may include the application and clearance of a fault of defined severity.
single credible contingency event	An individual *credible contingency event* for which a *User* adversely affected by the event would reasonably expect, under normal conditions, the design or operation of the relevant part of the meshed *power system* would adequately cater, so as to avoid significant disruption to *power system security*.
small disturbance	The disturbance is considered to be sufficiently small if linearization of system equations is permissible 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, generator AVR setpoint changes, etc.
small zone fault	A fault which occurs on an area of *plant* that is within the zone of detection of a *protection scheme*, but for which not all contributions will be cleared by the circuit breaker(s) tripped by that *protection scheme*. For example, a fault in the area of *plant* between a *current transformer* and a circuit breaker, fed from the *current transformer* side, may be a *small zone fault*.
South West Interconnected System	The *network* in South West of the state of Western Australia, extending from Geraldton to Albany areas and across to the Eastern Goldfields, as defined in the *Act*.
spare capacity	Any portion of firm capacity or non-firm capacity not committed to existing users.
standby power	Electricity generated by any person under an arrangement relating to the provision of standby, backup or emergency electricity for loads associated with a user, and includes such electricity generated by that user.
static excitation system	An *excitation control system* in which the power to the rotor of a synchronous *generating unit* is transmitted through high power solid-state electronic devices.
static VAR compensator	A device specifically provided on a *network* to provide the ability to generate and absorb *reactive power* and to respond automatically and rapidly to *voltage* fluctuations or *voltage* instability arising from a disturbance or disruption on the *transmission* or *distribution network.*

static synchronous compensator	A device specifically provided on a *network* to provide the ability to generate and absorb *reactive power* and to respond automatically and rapidly to *voltage* fluctuations or *voltage* instability arising from a disturbance or disruption on the *transmission* or *distribution network*
substation	A *facility* at which lines are switched for operational purposes. 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*.
synchronise	The act of *synchronising* a *generating unit* to the *power system*.
synchronising, synchronisation	To electrically *connect* a *generating unit* to the *power system*.
synchronous condensers	*Plant,* similar in construction to a *generating unit* of the *synchronous generator* category, which operates at the equivalent speed of the *frequency* of the *power system,* specifically provided to generate or absorb *reactive power* through the adjustment of rotor current.
synchronous generator voltage control	The automatic *voltage control system* of a *generating unit* of the *synchronous generator* category which changes the output *voltage* of the *generating unit* through the adjustment of the generator rotor current and effectively changes the *reactive power* output from that *generating unit.*
synchronous generator, synchronous generating unit	The alternating current generators which operate at the equivalent speed of the *frequency* of the *power system* in its *satisfactory operating state*.
tap-changing transformer	A *transformer* with the capability to allow internal adjustment of output *voltages* which can be automatically or manually initiated while on-line and which is used as a major component in the control of the *voltage* of the *transmission and distribution networks* in conjunction with the operation of *reactive plant*. The *connection point* of a *generating unit* may have an associated tap-changing transformer, usually provided by the *Generator.*
technical envelope	The limits described in clause 5.2.3.
teleprotection signalling	Equipment used to transfer a contact state from one location to another using communications equipment. The equipment used for this purpose will meet the *reliability* and quality requirements of *protection* equipment.
thermal generating unit	A generating unit which uses fuel combustion for electricity generation.
time	Western Standard Time, being the time at the 120th meridian of longitude east of Greenwich in England, or Co-ordinated Universal Time, as required by the National Measurement Act, 1960.
total fault clearance time	Refers to 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 10ms plus the circuit breaker maximum break time plus the maximum protection operating time.

transformer	A *plant* or device 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*.
transmission	Activities pertaining to a *transmission network* including the conveyance of electricity.
transmission element	A single identifiable major component of a *transmission network* involving: (a) an individual *transmission* circuit or a phase of that circuit; (b) a major item of *transmission plant* necessary for the functioning of a particular *transmission* circuit or *connection point* (such as a *transformer* or a circuit breaker).
transmission line	A power line that is part of a *transmission network*.
transmission network	See definition for *electricity transmission network*.
transmission network connection point	A *connection point* on a *transmission network*.
transmission network test	Test conducted to verify the magnitude of the *power transfer capability* of the *transmission network* or investigating *power system* performance in accordance with clause 4.1.7.
transmission plant	Apparatus or equipment associated with the function or operation of a *transmission line* or an associated *substation*, which may include *transformers*, circuit breakers, *reactive plant* and *monitoring equipment* and control equipment.
trip circuit supervision	A function incorporated within a *protection* that results in alarming for loss of integrity of the *protection's* trip circuit. *Trip circuit supervision* supervises a *protection's* trip supply together with the integrity of associated wiring, cabling and circuit breaker trip coil.
trip supply supervision	A function incorporated within a *protection* that results in alarming for loss of trip supply.
turbine control system	The automatic *control system* which regulates the speed and power output of a *generating unit* through the control of the rate of entry into the *generating unit* of the primary *energy* input (for example, steam, gas or water). Old terminology is governor system.

two fully independent protections of differing principle	Where an item of *plant* is required to be protected by t*wo fully independent protections of differing principle*, such *protections* shall, in combination, provide dependable clearance of faults on that *plant* within a specified time, with any single failure to operate of the *secondary plant*. To achieve this, complete *secondary plant* redundancy is required including, but not necessarily limited to, *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 fully independent *protection* would need to have its own independent battery and battery charger system supplying all that *protection's* trip functions. The *protections* shall be so chosen as to have *differing principles* of operation.
unit protection	Generally, a *protection scheme* that compares the conditions at defined *primary plant* boundaries and can positively identify whether a fault is internal or external to the protected *plant*. *Unit protection schemes* can provide high speed (less than 150 milliseconds) *protection* for the protected *primary plant*. Generally, *unit protection schemes* will not be capable of providing *back up protection*.
user	Has the meaning given in the *Access Code*.
voltage	The electronic force or electric potential between two points that gives rise to the flow of electricity.
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.
Western Power	Has the meaning given as "Western Power Corporation" in the *Access Code*, but modified in accordance with clause 1.2 of this *Rules*.
Western Power power system security responsibilities	The responsibilities described in clause 5.3.1.

ATTACHMENT 2

RULES OF INTERPRETATION

Subject to the Electricity Industry Act 2004 "*Act*" and Electricity Networks Access Code 2004 "*Access Code*", these *Rules* must be interpreted in accordance with the following rules of interpretation, unless the contrary intention appears:

(a) a reference in these *Rules* to a contract or another instrument includes a reference to any amendment, variation or replacement of it;

(b) a reference to a person includes a reference to the person's executors, administrators, successors, substitutes (including, without limitation, persons taking by novation) and assigns;

(c) if an event must occur on a *day* which is not a *business day* then the event must occur on the next *business day*;

(d) any calculation shall be performed to the accuracy, in terms of a number of decimal places, determined by *Western Power* in respect of all *Users*;

(e) if examples of a particular kind of conduct, thing or condition are introduced by the word "**including**", then the examples are not to be taken as limiting the interpretation of that kind of conduct, thing or condition;

(f) a *connection* is a *User's connection* or a *connection* of a *User* if it is the subject of an *access contract* between the *User* and *Western Power*; and

(g) 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.

ATTACHMENT 3

SUMMARY OF SCHEDULES OF TECHNICAL DETAILS TO SUPPORT APPLICATION FOR CONNECTION AND ACCESS CONTRACT

A3.1. Various sections of the *Code* require that *Users* submit technical data to *Western Power*. 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 *Western Power* at the time of assessment of a *transmission or distribution access application*, and will form part of the technical specification in the *access contract*.

A3.2. Data is coded in categories, according to the stage at which it is available in the build-up of data during the process of forming a *connection* or obtaining access to a *network*, with data acquired at each stage being carried forward, or enhanced in subsequent stages, eg. by testing.

Preliminary system planning data

This is data required for submission with the *access application*, to allow *Western Power* to prepare an offer of terms for an *access contract* and to assess the requirement for, and effect of, *network augmentation* or *extension* options. Such data is normally limited to the items denoted as Standard Planning Data (S) in the technical data schedules S1 to S5.

Western Power may, in cases where there is reasonable doubt as to the viability of a proposal, require the submission of other data before making an access offer to *connect* or to amend an *access contract*.

Registered system planning data

This is the class of data which will be included in the *access contract* signed by both parties. It consists of the preliminary system planning data plus those items denoted in the attached schedules as Detailed Planning Data (D). The latter must be submitted by the *User* in time for inclusion in the *access contract*.

Registered data

Registered Data consists of data validated and *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. *Western Power* 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 *Western Power* of the revised data, together with authentication documents, eg. test reports.

A3.4. Schedules S1 to S5, which are given in the respective Attachments 4 to 8, cover the following data areas:

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

(b) Schedule S2 - *Generating Unit* Setting Data. This comprises settings which can be varied by agreement or by *direction* of *Western Power*.

(c) Schedule S3 - *Transmission Network* and *Plant* Technical Data. This comprises fixed electrical parameters.

(d) Schedule S4 - *Transmission Plant* and Apparatus Setting Data. This comprises settings which can be varied by agreement or by *direction* of *Western Power*.

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

A3.5. A *Generator* that *connects* a *generating unit*, that is not a *synchronous generating unit*, must be given exemption from complying with those parts of schedules S1 and S2 that are determined by *Western Power* to be not relevant to such *generating units*, but must comply with those parts of Schedules S3, S4, and S5 that are relevant to such *generating units*, as determined by *Western Power*. For this non-synchronous generating unit, additional data may be requested by Western Power.

Codes:

S = Standard Planning Data

D = Detailed Planning Data

R = Registered Data (R1 pre-*connection*, R2 post-*connection*)

ATTACHMENT 4

SCHEDULE S1 - GENERATING UNIT DESIGN DATA

Symbol	Data Description	Units	Data Category
	Power Station Technical Data:		
	Connection Point to *Network*	Text, diagram	S, D
	Nominal *voltage* at *connection* to *Network*	kV	S
	Total Station Net Maximum Capacity (NMC)	MW (*sent out*)	S, D, R2
	At Connection Point:		
	Maximum 3 phase short circuit infeed calculated by method of AS 3851 (1991)		
	· Symmetrical	kA	S, D
	· Assymetrical	kA	D
	Minimum zero sequence impedance	(a+jb)% on 100 MVA base	D
	Minimum negative sequence impedance	(a+jb)% on 100 MVA base	D
	Individual Synchronous Generating Unit Data:		
	Make		
	Model		
MBASE	Rated MVA	MVA	S, D, R1
PSO	Rated MW (*Sent Out*)	MW (*sent out*)	S, D, R1
PMAX	Rated MW (*Generated*)	MW (Gen)	D
VT	Nominal Terminal *Voltage*	kV	D, R1
PAUX	Auxiliary *load* at PMAX	MW	S, D, R2
Qmax	Rated Reactive Output at PMAX	MVAr (*sent out*)	S, D, R1
PMIN	*Minimum Load* (ML)	MW (*sent out*)	S, D, R2
H	Inertia Constant for all rotating masses connected to the generator shaft (for example, generator, turbine, etc)	MWs/rated MVA	S, D, R1
Hg	*Generator* Inertia Constant (applicable to *synchronous condenser* mode of operation)	MWs/rated MVA	S, D, R1
GSCR	Short Circuit Ratio		D, R1
ISTATOR	Rated Stator Current	A	D, R1
IROTOR	Rated Rotor Current at rated MVA and *Power Factor*, rated terminal volts and rated speed	A	D,R1
VROTOR	Rotor *Voltage* at which IROTOR is achieved	V	D, R1
VCEIL	Rotor *Voltage* capable of being *supplied* for five seconds at rated speed during field forcing	V	D, R1
ZN	Neutral Earthing Impedance	(a+jb)% on MVA base	
	Generating Unit Resistance:		
RA	Stator Resistance	% on MBASE	S, D, R1, R2
RF	Rotor resistance at 20°C	ohms	D, R1

Symbol	Data Description	Units	Data Category
	Generating Unit Sequence Impedances (saturated):		
Z0	Zero Sequence Impedance	(a+jb)% on MBASE	D,R1
Z2	Negative Sequence Impedance	(a+jb)% on MBASE	D,R1
	Generating Unit Reactances (saturated):		
XD'(sat)	Direct Axis Transient Reactance	% on MBASE	D,R1
XD"(sat)	Direct Axis Sub-Transient Reactance	% on MBASE	D,R1
	Generating Unit Reactances (unsaturated):		
XD	Direct Axis Synchronous Reactance	% on MBASE	S, D, R1, R2
XD'	Direct Axis Transient Reactance	% on MBASE	S, D, R1, R2
XD"	Direct Axis Sub-Transient Reactance	% on MBASE	S, D, R1, R2
XQ	Quadrature Axis Synch Reactance	% on MBASE	D, R1, R2
XQ'	Quadrature Axis Transient Reactance	% on MBASE	D, R1, R2
XQ"	Quadrature Axis Sub-Transient Reactance	% on MBASE	D,R1, R2
XL	Stator Leakage Reactance	% on MBASE	D, R1, R2
XO	Zero Sequence Reactance	% on MBASE	D, R1
X2	Negative Sequence Reactance	% on MBASE	D, R1
XP	Potier Reactance	% on MBASE	D, R1
	Generating Unit Time Constants (unsaturated):		
TDO'	Direct Axis Open Circuit Transient	Seconds	S, D, R1, R2
TDO"	Direct Axis Open Circuit Sub-Transient	Seconds	S, D, R1, R2
TKD	Direct Axis Damper Leakage	Seconds	D, R1, R2
TQO'	Quadrature Axis Open Circuit Transient	Seconds	D, R1, R2
TA	Armature Time Constant	Seconds	D, R1, R2
TQO"	Quadrature Axis Open Circuit Sub-Transient	Seconds	D, R1, R2
	Charts:		
GCD	Capability Chart	Graphical data	D, R1, R2
GOCC	Open Circuit Characteristic	Graphical data	R1
GSCC	Short Circuit Characteristic	Graphical data	R1
GZPC	Zero *power factor* curve	Graphical data	R1
	V curves	Graphical data	R1
GOTC	MW, MVAr outputs versus temperature chart	Graphical data	D, R1, R2
	Generating Unit Transformer:		
GTW	Number of windings	Text	S, D
GTRn	Rated MVA of each winding	MVA	S, D, R1
GTTRn	Principal tap rated *voltage*s	kV/kV	S, D, R1
GTZ1n	Positive Sequence Impedances (each wdg)	(a + jb) % on 100 MVA base	S, D, R1
GTZ2n	Negative Sequence Impedances (each wdg)	(a + jb) % on 100 MVA base	S, D, R1

Symbol	Data Description	Units	Data Category
GTZOn	Zero Sequence Impedances (each wdg)	(a + jb) % on 100 MVA base	S, D, R1
	Tapped Winding	Text, diagram	S, D, R1
GTAPR	Tap Change Range	kV - kV	S, D
GTAPS	Tap Change Step Size	%	D
	Tap Changer Type, On/Off load	On/Off	D
	Tap Change Cycle Time	Seconds	D
GTVG	Vector Group	Diagram	S, D
	Earthing Arrangement	Text, diagram	S, D
	Saturation curve	Diagram	R1
	Generating Unit Reactive Capability (At machine terminals):		
	Lagging *Reactive Power* at PMAX	MVAr export	S, D, R2
	Lagging *Reactive Power* at ML	MVAr export	S, D, R2
	Lagging Reactive Short Time capability at rated MW, terminal *voltage* and speed	MVAr (for time)	D, R1, R2
	Leading *Reactive Power* at rated MW	MVAr import	S,D, R2
	Generating Unit Excitation System:		
	Make		
	Model		
	General description of *excitation control system* (including block diagram transfer function & parameters)	Text, diagram	S, D
	Rated Field *Voltage* at rated MVA and *Power Factor* and rated terminal volts and speed	V	S, D, R1
	Maximum Field *Voltage*	V	S, D, R1
	Minimum Field *Voltage*	V	D, R1
	Maximum rate of change of Field *Voltage*	Rising V/s	D, R1
	Maximum rate of change of Field *Voltage*	Falling V/s	D, R1
	Generating Unit and exciter Saturation Characteristics 50 - 120% V	Diagram	D, R1
	Dynamic Characteristics of Over *Excitation* Limiter (drawn on capability generator diagram)	Text/ Block diagram	D, R2
	Dynamic Characteristics of Under *Excitation* Limiter (drawn on capability generator diagram)	Text/ Block diagram	D, R2
	Generating Unit Turbine / Load Controller (Governor):		
	Make		
	Model		
	General description of turbine *control system* (including block diagram transfer function & parameters)	Text, diagram	S, D
	Maximum Droop	%	S, D, R1

Symbol	Data Description	Units	Data Category
	Normal Droop	%	D, R1
	Minimum Droop	%	D, R1
	Maximum *Frequency* Dead band	Hz	D, R1
	Normal *Frequency* Deadband	Hz	D, R1
	Minimum *Frequency* Deadband	Hz	D, R1
	MW Deadband	MW	D, R1
	Generating Unit Response Capability:		
	Sustained response to *frequency* change	MW/Hz	D, R2
	Non-sustained response to *frequency* change	MW/Hz	D, R2
	Load Rejection Capability	MW	S, D, R2
	Mechanical Shaft Model: (Multiple-Stage Steam Turbine Generators only)		
	Dynamic model of turbine/*Generator* shaft system in lumped element form showing component inertias, damping and shaft stiffness.	Diagram	D
	Natural damping of shaft torsional oscillation modes.(for each mode)		
	- Modal *frequency*	Hz	D
	- Logarithmic decrement	Nepers/Sec	D
	Steam Turbine Data: (Multiple-Stage Steam Turbines only)		
	Fraction of power produced by each stage:		
	Symbols KHP KIP KLP1 KLP2	Per unit of Pmax	D
	Stage and Reheat Time Constants:		
	Symbols THP TRH TIP TLP1 TLP2	Seconds	D
	Turbine frequency tolerance curve	Diagram	S, D, R1
	Gas Turbine Data:		
HRSG	Waste heat recovery boiler time constant (where applicable eg for cogeneration plant)	Seconds	D
	MW output versus turbine speed (47-52 Hz)	Diagram	D, R1, R2
	Type of turbine (heavy industrial, aero derivative etc)	Text	S
	Number of shafts		S,D
	Gearbox Ratio		D

Symbol	Data Description	Units	Data Category
	Fuel type (gas, liquid)	Text	S,D
	Base load MW vs temperature	Diagram	D
	Peak Load MW vs temperature	Diagram	D
	Rated exhaust temperature	°C	S,D
	Controlled exhaust temperature	°C	S,D,R1
	Turbine frequency tolerance capability	Diagram	D
	Turbine compressor surge map	Diagram	D
	Hydraulic Turbine Data		
	Required data will be advised by Western Power		
	Windfarm/Wind Turbine Data[1)]		
	A typical 24 hour power curve measured at 15-minute intervals or better if available;		S, D, R1
	maximum kVA output over a 60 second interval		S, D,R1
	Long-term flicker factor for generator		S, D, R1
	Long term flicker factor for windfarm		S,D,R1
	Maximum output over a 60 second interval	kVA	S,D,R1
	Harmonics current spectra	A	S,D,R1
	Power curve MW vs windspeed	Diagram	D
	Spatial Arrangement of windfarm	Diagram	D
	Startup profile MW, MVAr vs time for individual Wind Turbine Unit and Wind Farm Total	Diagram	D
	Low Wind Shutdown profile MW, MVAr vs time for individual Wind Turbine Unit and Wind Farm Total	Diagram	D
	MW, MVAr vs time profiles for individual Wind Turbine Unit under normal ramp up and ramp down conditions.	Diagram	D
	High Wind Shutdown profile MW, MVAr vs time for individual Wind Turbine Unit and Wind Farm Total	Diagram	D
	Induction Generator Data		
	Make		
	Model		
	Type (squirrel cage, wound rotor, doubly fed)		
MBASE	Rated MVA	MVA	S,D,R1
PSO	Rated MW (*Sent out*)	MW	S,D,R1
PMAX	Rated MW (*Generated*)	MW	D
VT	Nominal Terminal Voltage	kV	S,D,R1
	Synchronous Speed	rpm	S,D,R1
	Rated Speed	rpm	S,D,R1
	Maximum Speed	rpm	S,D,R1
	Rated Frequency	Hz	S,D,R1
Qmax	Reactive consumption at PMAX	MVAr import	S,D,R1

[1)] Measurement of power quality characteristics (including flicker and harmonics) in accordance with IEC 61400-21 shall be provided for all wind turbines proposed for connection to the network. This will require a test report on flicker and harmonics in accordance with IEC61400-21

Symbol	Data Description	Units	Data Category
	Curves showing torque, power factor, efficiency, stator current, MW output versus slip (+ and -).	Graphical data	D,R1,R2
	Number of capacitor 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 generator shaft (for example, generator, turbine, gearbox, etc) calculated at the synchronous speed	MW-sec/MVA	S,D,R1
	Resistance		
Rs	Stator resistance	% on MBASE	D,R1
Rs	Stator resistance versus slip curve, or two extreme values for zero (nominal) and unity (negative) slip	Graphical data or % on MBASE	D,R1
	Reactances (saturated)		
X’	Transient reactance	% on MBASE	D,R1
X’’	Subtransient reactance	% on MBASE	D,R1
	Reactances (unsaturated)		
X	Sum of magnetising and primary winding leakage reactance.	% on MBASE	D,R1
X’	Transient reactance	% on MBASE	D,R1
X’’	Subtransient reactance	% on MBASE	D,R1
Xl	Primary winding leakage reactance	% on MBASE	D,R1
	Time Constants (unsaturated)		
T’	Transient	sec	S,D,R1,R2
T’’	Subtransient	sec	S,D,R1,R2
Ta	Armature	sec	S,D,R1,R2
To’	Open circuit transient	sec	S,D,R1,R2
To’’	Open circuit subtransient	sec	S,D,R1,R2
	Converter Data		
	Control: network commutated or self commutated Additional data may be required by Western Power		
	Doubly Fed Induction Generator Data		
	Required data will be advised by Western Power		

ATTACHMENT 5

SCHEDULE S2 - GENERATING UNIT SETTING DATA

Description Category	Units	Data
Protection Data:		
Settings of the following protections:		
Loss of field	Text	D
Under *excitation*	Text, diagram	D
Over *excitation*	Text, diagram	D
Differential	Text	D
Under *frequency*	Text	D
Over *frequency*	Text	D
Negative sequence component	Text	D
Stator overvoltage	Text	D
Stator overcurrent	Text	D
Rotor overcurrent	Text	D
Reverse power	Text	D

Control Data:

Details of *excitation control system* incorporating, where applicable, individual elements for power system stabiliser, under excitation limiter and over excitation limiter described in block diagram form showing transfer functions of individual elements, parameters and measurement units (preferably in IEEE format, but suitable for use in the software package nominated by Western Power. Currently, that package is PSS/E): The source code of the model shall also be provided, as per clause 3.2.10.

	Text, diagram	D,R1,R2

Settings of the following controls:

Details of the turbine control *system* described in block diagram form showing transfer functions of individual elements and measurement units (preferably in IEEE format, but suitable for use in the software package nominated by Western Power. Currently, that package is PSS/E). The source code of the model shall also be provided, as per clause 3.2.10.

	Text, diagram	D,R1,R2
Stator current limiter (if fitted)	Text, diagram	D
Manual restrictive limiter (if fitted)	Text	D
Load drop compensation/VAr sharing (if fitted)	Text, function	D
V/f limiter (if fitted)	Text, diagram	D

ATTACHMENT 6

SCHEDULE S3 NETWORK AND PLANT TECHNICAL DATA OF EQUIPMENT AT OR NEAR CONNECTION POINT

Description	Units	Data Category
Voltage Rating		
Nominal v*oltage*	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
Network 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 *voltage*s.	Single line Diagrams	S, D, R1
Network Impedances		
For each item of *plant* (including lines): details of the positive, negative and zero sequence series and shunt impedances, including mutual coupling between physically adjacent elements.	% on 100 MVA base	S, D, R1
Short Circuit Infeed to the Network		
Maximum *Generator* 3-phase short circuit infeed including infeeds from *generating units connected* to the *User's system*, calculated by method of AS 3851 (1991).	kA symmetrical	S, D, R1
The total infeed at the instant of fault (including contribution of induction motors).	kA	D, R1

Description	Units	Data Category
Minimum zero sequence impedance of *User's network* at *connection point*.	% on 100 MVA base	D, R1
Minimum negative sequence impedance of *User's network* 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 Network:		
For all *generating units*, all connecting lines/cables, *transformers* etc.		
Series Resistance (+ve, -ve & zero seq.)	% on 100 MVA base	D, R
Series Reactance (+ve, -ve & zero seq.)	% on 100 MVA base	D, R
Shunt Susceptance (+ve, -ve & zero seq.)	% on 100 MVA base	D, R
Normal and short-time emergency ratings	MVA	D,R
Technical Details of *generating units* as per schedules S1, S2		
Transformers* at *connection points:		
Saturation curve	Diagram	R

ATTACHMENT 7

SCHEDULE S4 - NETWORK PLANT AND APPARATUS SETTING DATA

Description	Units	Data Category
Protection Data for Protection relevant to Connection Point:		
Reach of all *protections* on *transmission lines*, or cables	ohms or % on 100 MVA base	S, D
Number of *protections* on each item	Text	S, D
Total fault clearing times for near and remote faults	ms	S, D, R1
Line reclosure sequence details	Text	S, D, R1
Tap Change Control Data:		
Time delay settings of all *transformer* tap changers.	Seconds	D, R1
Reactive Compensation (including filter banks):		
Location and Rating of individual *shunt reactors*	MVAr	D, R1
Location and Rating of individual *shunt capacitor* banks	MVAr	D, R1
Capacitor Bank capacitance	microfarads	D
Inductance of switching reactor (if fitted)	millihenries	D
Resistance of capacitor plus reactor	Ohms	D
Details of special controls (e.g. Point-on-wave switching)	Text	D
For each shunt reactor or capacitor bank (including filter banks):		
Method of switching	Text	S
Details of automatic control logic such that operating characteristics can be determined	Text	D, R1
FACTS Installation:		
Data sufficient to enable static and dynamic performance of the installation to be modelled	Text, diagrams control settings	S, D, R1
Under frequency load shedding scheme:		
Relay settings (frequency and time)	Hz, seconds	S, D
Islanding scheme:		
Triggering signal (e.g. voltage, frequency)	Text	S, D
Relay settings	Control settings	S, D

ATTACHMENT 8

SCHEDULE S5 - LOAD CHARACTERISTICS AT CONNECTION POINT

Data Description	Units	Data Category
For all Types of Load		
Type of *Load* eg controlled rectifiers or large motor drives	Text	S
Rated capacity	MW, MVA	S
Voltage level	kV	S
Rated current	A	S
For Fluctuating Loads		
Cyclic variation of *active power* over period	Graph MW/time	S
Cyclic variation of *reactive power* over period	Graph MVAr/time	S
Maximum rate of change of *active power*	MW/s	S
Maximum rate of change of *reactive power*	MVAr/s	S
Shortest Repetitive time interval between fluctuations in *active power* and *reactive power* reviewed annually	s	S
Largest step change in *active power*	MW	S
Largest step change in *reactive power*	MVAr	S
For commutating power electronic load:		
No. of pulses	Text	S
Maximum *voltage* notch	%	S
Harmonic current distortion (up to the 50th harmonic)	A or %	S

ATTACHMENT 9

TEST SCHEDULE FOR SPECIFIC PERFORMANCE VERIFICATION AND MODEL VALIDATION

A9.1 General

(a) Recorders should be calibrated/checked prior to use.
(b) Recorders should not interact with any *plant* control functions.
(c) One chart recorder shall be used to provide on site monitoring and rapid evaluation of key quantities during tests even though a digital recorder may be used.

A9.2 Recorder Equipment

Digital Recorder

Signals which are to be digitally recorded and processed require:
(a) an analogue to digital conversion with at least 12 bit accuracy at full scale.
(b) a sampling rate of at least 3000 samples per second (ie 3kHz) for up to 20 seconds unless specified otherwise.
(c) recordings in ASCII format in either a 3½” floppy disc or zip disc readable on IBM or IBM compatible computer.
(d) departure from linearity of no more than 0.1% in the slope of normalised output versus input. Normalised means value/full range value.
(e) DC offset errors not greater than 0.05% of full scale in the analogue circuitry.
(f) 20 - 30 recording channels are required

Chart Recorder

Signals which are to be recorded on charts require:
(a) a chart speed of at least 20mm/sec
(b) at least 10 second recording period
(c) at least 30mm in deviation of quantities
(d) compliance with (d) & (f) of requirements for Digital Recorder

Tape Recorder

Signals which are to be recorded on Tape require :
(a) analogue to digital transcription for analogue recordings **or** transcription to multiple chart recordings which are properly annotated.
(b) production of digital data in ASCII format on either a 31/2” floppy disc or zip disc.
(c) compliance with (d) & (f) of requirements for Digital Recorder.

A9.3 Frequency response

(a) Where digital or chart recordings of power *frequency* waveforms are to be made a minimum bandwidth of DC - 10kHz is desirable (0dB at DC, -3dB at 10kHz). Suitable filtering is required to eliminate aliasing errors.
(b) For relatively slowly changing signals (such as main exciter quantities, transducers for MW output etc) a recording device bandwidth of DC - 100Hz is desirable, the minimum acceptable bandwidth being DC - 10Hz.

A9.4 Signal Requirements and Conditioning

(a) Suitable input signal level should 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* should be provided so that any perturbations are clearly observable on an on site chart recorder

(c) Galvanic isolation and filtering of input signals should be provided whenever necessary.

A9.5 Form of Test Results

These shall 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 network configuration.

(d) lists of data collected manually (eg meter readings).

(e) data in ASCII format.

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

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

A9.6 Test Preparation And Presentation of Test Results

Information/data prior to tests

(a) a detailed schedule of tests agreed by *Western Power*. The schedule should 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 Attachments 4 to 8 of these *Rules*.

Test Notification

(a) A minimum of 15 business day prior notice of test commencement should be given to Western power for the purpose of arranging witnessing of tests.

(b) Western Power's representative should 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 should be conducted consecutively.

Test Results

(a) Test result data must be presented to *Western Power* within 10 *business days* of completion of each test or test series.

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

A9.7 Quantities to be Measured

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

Generator and Excitation System

- 3 stator L-N terminal *voltages*
- 3 stator terminal currents
- *Active Power* MW
- *Reactive Power* MVAR
- Generator rotor field *voltage*
- Generator rotor field current
- Main exciter field *voltage*
- Main exciter field current
- AVR reference *voltage*
- *Voltage* applied to AVR summing junction (step etc)
- *Power system* stabiliser output
- DC signal input to AVR

Steam Turbine

- Shaft speed
- Load demand signal
- Valve positions for control and interceptor valves
- Turbine control setpoint

Gas turbine

- Shaft speed (engine)
- Shaft speed of turbine driving the generator
- Engine speed control output
- Free turbine speed control output
- Generator-compressor speed control output
- Ambient/turbine air inlet temperature
- Exhaust gas temperature control output
- Exhaust temperature
- Fuel flow
- Turbine control /load reference set point

Hydro

- Shaft speed
- Gate position
- Turbine control /load reference set point

(a) Western Power will specify test quantities for power plant other than those listed above, such as those consisting of wind, solar and fuel cell generators which may also involve AC/DC/AC power conversion or DC/AC power inverters.

(b) Additional test quantities may be requested and advised by *Western Power* if other special tests are necessary.

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

SCHEDULE OF TESTS

Table A9.1 - Schedule of tests

	TEST DESCRIPTION		
Test No	General Description	Changes Applied	Test Conditions
C1	Step change to AVR voltage reference with the generator on open circuit	(a) +2.5 % (b) -2.5 % (c) +5.0 % (d) -5.0 %	• nominal stator terminal volts
C2A	*Step change to AVR voltage reference with the generator connected to the system.* (with the Power System Stabiliser out of service) Generator output levels: (i)50% rated MW, and (ii)100% rated MW	(a) +1.0 % (b) -1.0 % (c) +2.5 % (d) -2.5 % (e) +5.0 % (f) -5.0 % repeat (e) & (f) twice see note i. below	• nominal stator terminal volts • unity or lagging power factor • system base load OR typical conditions at the local plant and typical electrical connection to the transmission or distribution system • tests for (i) should precede tests for (ii) • smaller step changes should precede larger step changes
C2B	*As for C2A but with the PSS in service*	Same as in C2A	Same as in C2A
C3A	*Step change to AVR voltage reference with the generator connected to the system.* (With PSS out of service)	(a) +5 % (b) –5 % repeat (a) & (b) twice; see note v. below	• nominal stator terminal volts • unity or lagging power factor

	TEST DESCRIPTION		
Test No	General Description	Changes Applied	Test Conditions
	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		• Generator output at 100% rated MW
C3B	As for C3A but with the PSS in service	Same as in C3A	As for C3A.
C4	Step change of MVA on the transmission or distribution system PSS Status : (i) PSS in service, and (ii) PSS out of service	Switching in and out of Transmission or distribution lines (nominated by Western Power)	• nominal stator terminal volts • unity or lagging power factor • system base load OR typical conditions at the local plant and typical electrical connection to the transmission or distribution system • generator output at 50% rated MW
C5	load rejection (real power)	(a) 25 % rated MW (b) 50 % rated MW (c) 100 % rated MW see notes below	• nominal stator terminal volts • unity power factor • smaller amount should precede larger amount of load rejection
C6	steady state over-excitation limiter (OEL) operation	MVAr outputs at OEL setting slow raising of excitation to just bring OEL into operation see notes below	• 100% MW output • 75% MW output • 50% MW output • 25% MW output • min.MW output

	TEST DESCRIPTION		
Test No	General Description	Changes Applied	Test Conditions
C7	steady state under-excitation limiter (UEL) operation	MVAr outputs at UEL setting slow lowering of excitation to just bring UEL into operation see notes below	• 100% MW output • 75% MW output • 50% MW output • 25% MW output • min. MW output
C8	Manual variation of generator open circuit voltage	Stator terminal volt (Ut) (a) increase from 0.5 pu to 1.1 pu (b) decrease from 1.1pu to 0.5 pu see notes below	• in 0.1 pu step for Ut between 0.5-0.9 pu • in 0.05 pu step for Ut between 0.9-1.1 pu
C9	MVAr capability at full MW output. System maximum load and maximum generation. Test conducted with as high an ambient temperature as possible.	Generator MW and MVAr output levels set to 100% of rated values and maintained for one hour.	• System maximum load and generation • Ambient temperature as high as possible

Notes:

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

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

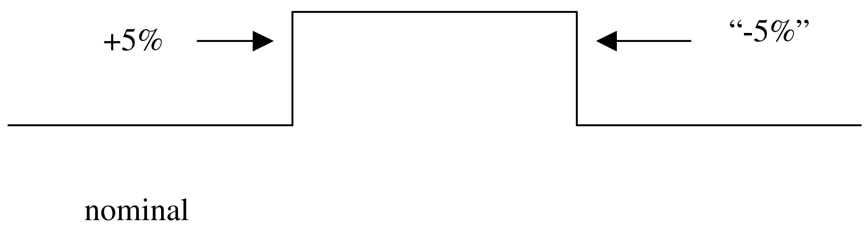

Figure A9.1 - Application of Step Signal

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

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

iv. “system” means “power system”

v. OR a lower step change, with a larger safety margin, as agreed by Western Power

vi. tests C1,C6, C7 and C8 need not be witnessed by Western Power

SPECIAL SYSTEM TESTS THAT MAY BE REQUESTED

Table A9.2 – Schedule of special system tests

Test No	TEST DESCRIPTION		
	General Description	**Changes Applied**	**Test Conditions**
S1	Load rejection (reactive power)	(a) -30 % rated MVAR (b) +25 % rated MVAR see notes below	• nominal stator terminal volts • 0 or minimum MW output
S2	Load rejection (reactive power)	(a) -30 % rated MVAR see notes below	• nominal stator terminal volts • Excitation on Manual Control
S3	Step change of MVAR on the transmission system	Switching in and out of (a) a transformer (b) a reactor (c) a capacitor	• parallel transformers on staggered taps others as determined by WPC
S4	Islanding of a subsystem consisting of User's generators plus load with export of power via a link to Western Power's main transmission system.	opening of the link	• 5-10% of generated MW exported via the link • 90-95% of generated MW used by the subsystem's load
S5	AVR/OEL changeover	transformer tap change OR small step to AVR voltage reference	• initially under AVR control at lagging power factor but close to OEL limit
S6	AVR/UEL changeover	transformer tap change OR small step to AVR voltage reference	• initially under AVR control at leading power factor but close to UEL limit
S7	Testing of a FACTS device (SVC, TCR, STATCOM, etc)	• step change to reference value in the summing junction of a control element • line switching • others as appropriate	• MVA initial conditions in lines as determined by WPC
S8	Tripping of an adjacent generator	tripping of generating unit(s)	• initial generator loading as agreed
S9	Variable frequency injection into the AVR summing junction (with PSS out of service)	0.01-100 rad/sec see notes below	• as determined by WPC
S10	Step change to governor/load reference	(a) 2.5 % step increase in MW demand signal (b) 2.5 % decrease in MW demand	• plant output at 50-85% of rated MW • others as agreed with Western Power

		signal (c) equivalent of 0.05Hz subtracted from the governor speed ref. (d) equivalent of 0.1 Hz added to governor speed reference see notes below	
S11	Overspeed capability to stay in the range of 52.0 to 52.5Hz for a minimum of 6 seconds	(a) Digital governor: use software, where practical, to put a step in the speed reference of the turbine governor such that the target speed is 52.0Hz and the overshoot in speed remains above 52Hz and in the range 52-52.5Hz for about 6 sec (b) Use a manual control to raise speed from 50Hz so as to stay in the 52 to 52.5 Hz range for a minimum of 6 sec (c) Where it is practical, use a function generator to inject an analogue signal in the appropriate summing junction, so that the turbine stays in the 52-52.5 Hz range for a minimum of 6 sec.	• Unsynchronised unit at rated speed and no load
S12	Underspeed capability	To be proposed by the manufacturer	

Notes:

i. For tests S1(a) and S2 the VAR absorption should be limited so that field voltage does not go below 50% of its value at rated voltage and at no load (ie rated stator terminal voltage with the generator on open circuit).

ii. For test S1(b) the VAR load should not allow stator terminal voltage to exceed 8% overvoltage (ie 108% of rated value) as a result of the applied change.

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

iv. For test S2, it may be easier to use AVR control first and then change to manual (provided the change is "bumpless") before the unit trips.

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

vi. For the tests S10 plant characteristics may require the changes be varied from the nominal values given. Larger changes may be considered in order to more accurately determine plant performance.

vii. For test S5 a positive step is applied of X% from the sub-OEL value. But for test S6 a –Y% step from the sub-UEL value as shown in Figure A9.2 is required.

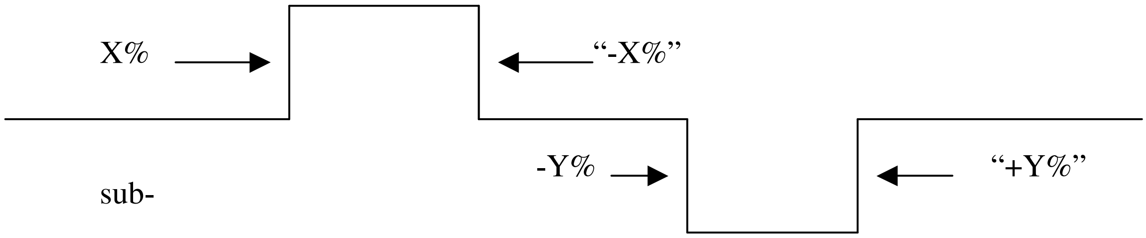

Figure A9.2 - Application of Step Signal

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