ELECTRICITY TRANSMISSION ACCESS

TECHNICAL CODE

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IMPORTANT NOTE: This document is subject to amendment (amendments must be performed in accordance with the Electricity Transmission Regulations 1996). People referring to this document are advised to consult the Manager Planning & Contracts, Western Power Corporation, to ensure that they have the latest version.

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. For the electricity transmission networks, open access to capacity commenced on 1 January 1997; the date on which the Electricity Transmission Regulations 1996 (the "Regulations") came into operation. Regulation 26 of the Regulations requires Western Power to publish a Technical Code ("Code"). In addition, regulation 27 of the Regulations requires Western Power to publish network planning criteria. The network planning criteria is included in this document.

This Code details the technical requirements to be met by Western Power on its transmission networks and by Users who connect facilities to the transmission networks. In addition, the planning criteria to be applied to the network is contained within this Code. Prospective Users or existing Users who wish to connect facilities to the transmission networks must first submit an access application to Western Power in accordance with Part 2 of the Regulations.

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

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

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1 GENERAL

1.1 AUTHORISATION

This *Technical Code* ("*Code*") is made under regulation 26 of the Electricity Transmission Regulations ("*Regulations*"). The *Code* sets out:

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

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

(c) requirements relating to the operation of the *electricity transmission network* (including the operation of the *electricity transmission 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 Code*;

(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 network*;

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

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

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

(k) procedures relating to the operation of *generating units* and other *plant* or equipment as part of or *connected* to the *electricity transmission 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 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 network*) or *plant* or equipment *connected* directly or indirectly to the *electricity transmission network*; and

(p) the *network planning criteria* as required by regulation 27 of the *Regulations*.

1.2 APPLICATION

In this *Technical Code*, unless otherwise stated, a reference to *Western Power* refers to the Transmission Division of *Western Power* for the *South West Transmission Network* and refers to the Transmission Section of the Pilbara Power Division of *Western Power* for the *North West Transmission Network*.

1.2.1 This *Code* applies to:

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

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

(c) every person to whom access to electricity transmission 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 agreement*); and

(d) the *Electricity Referee*.

1.2.2 This *Code* applies to all *plant* and equipment installed:

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

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

1.3 COMMENCEMENT

This *Code* comes into operation on 31 March 1997 ("*Code commencement date*").

1.4 INTERPRETATION

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

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

1.5 DISPUTE RESOLUTION

All disputes concerning this *Code* are to be resolved according to the Dispute Resolution and Electricity Referee Regulations.

1.6 OBLIGATIONS

1.6.1 Obligations of *Users*

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 *Regulations*;
(c) the requirements of this *Code*; and
(d) *good electricity industry practice* and applicable *Australian Standards*.

Refer to regulation 41 (Liability, insurance and indemnity) of the *Regulations*.

1.6.2 Obligations of *Western Power*

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

1) described in this *Code*; and
2) in accordance with any *access agreement* with a *User*.

(b) *Western Power* must:

(1) ensure that to the extent that a *connection point* relates to the *electricity transmission network*, every arrangement for *connection* with a *User* complies with all relevant provisions of this *Code*;
(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 agreement* 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 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 of interruptions to *agreed capability* at a *connection point* on or with that *network* 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*.

1.6.3 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 agreement* 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 voluntary *disconnection* in accordance with clause 4.3.

1.6.4 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 agreement* 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.

1.7 VARIATIONS AND EXEMPTIONS FROM, AND AMENDMENTS TO, THE CODE

1.7.1 Variations And Exemptions To The Code

Various clauses throughout this *Code* permit variations or exemptions from *Code* 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 agreement*.

In all cases, the requirements of this *Code* can only be varied or waived for a *User* in accordance with the provisions of regulations 26(6), 26(7), 26(8), 26(9), 26(10) and 26(11) of the *Regulations*. As stated in regulation 26(9) of the *Regulations*, any such variation or exemption must be given in writing to *User(s)* by *Western Power*.

1.7.2 Amendments to the Code

Western Power may amend this *Code* only in accordance with regulation 26(2) of the *Regulations*.

2. *TRANSMISSION NETWORK* PERFORMANCE CRITERIA

2.1 INTRODUCTION

This Section describes the technical performance requirements of the *transmission 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 7 - *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 (at the *User's* cost) 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 *Regulations* and this *Code*.

2.2 *FREQUENCY* VARIATIONS

Western Power and *Users* must ensure that within the *power system frequency range* 47 to 52 Hz, 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 2.6, or is required by *Western Power* to be switched for operational purposes. The minimum duration of operation at *frequencies* in the ranges 47 to 49.5 Hz and 50.5 to 51.5Hz for the *South West Transmission Network*, and 47 to 49.25Hz and 50.75 to 51.5Hz in the *North West Transmission Network*, shall be in accordance with Figure 6 of the standard ANSI/IEEE Std.C37.106-1987. The 60Hz *frequencies* quoted in the standard should be adjusted to their 50Hz equivalent *frequencies* by applying a factor of 0.83 to the 60Hz *frequencies*. Minimum duration of operation at *frequencies* in the range 51.5Hz to 52Hz should be 1 minute.

Sustained operation outside the range 47 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.* In the case of operation below 47Hz but at or above 45Hz, all *generators* shall remain *connected* to the *Western Power network* for a period of at least 2 seconds. Below 45Hz, instantaneous tripping of *generators* is permitted.

Western Power will require the use of *load shedding facilities* (described in clause 2.6 in this section) to aid recovery of *frequency* to the range 49.5Hz to 50.5Hz in the *South West Transmission Network* and 49.25Hz to 50.75Hz in the *North West Transmission Network*. Restoration of *frequency* to within steady state limits (49.8Hz to 50.2Hz for the *South West Transmission Network* and 49.6Hz to 50.4Hz for *the North West Transmission Network*) shall then be accomplished by operator action.

Frequency stability 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 *interconnect*ing *plant* leading to the formation of 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 2.6 to aid recovery of *frequency* to the range 49.5Hz to 50.5Hz in the *South West Transmission Network* and 49.25Hz to 50.75Hz in the *North West Transmission Network*.

2.3 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 network* will be 90% of nominal *voltage* and the maximum steady state *voltage* will be 110% of nominal *voltage*. However, the limits that apply in different parts of the *power system* are dictated by considerations of economics or *voltage* stability or the design of existing equipment. Other limits may apply following detailed *load*-flow and stability studies.

A requirement for a target range of *voltage* magnitude at a *connection point* must be specified in *access agreement*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 such faults, one or more of the phase to ground *voltage*s may fall to zero or may rise above the nominal *voltage* level).

Western Power and *Users* must ensure that each *facility* that is part of a *transmission 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).

2.4 *QUALITY OF SUPPLY*

2.4.1 Voltage Fluctuations

A *User* must ensure that variations in current at each of its *connection points* including those arising from the *energisation*, *de-energisation* or operation of any *plant* within or supplied from the *User's facilities* are such that the contribution to the magnitude and rate of occurrence of the resulting *voltage* disturbance does not exceed the limit set by the threshold of perceptibility set out in Figure 1 of *Australian Standard* AS2279, Part 4. The limits shown in Figure 1 of *Australian Standard* AS2279, Part 4 are the maximum allowable limits at the *connection point* for the particular *frequency* or magnitude of fluctuation. When assessing individual cases, the limits will be reduced as permitted by Section 7.2(d) of *Australian Standard* AS2279, Part 4, to account for the combined effect of several disturbances.

The limit to *voltage* fluctuation contribution is subject to verification of compliance by *Western Power*.

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 this clause 2.4.1.

Responsibility of *Western Power* for excursions in *voltage* fluctuations outside the range specified in this clause 2.4.1 must be limited to the pursuit of all measures available under the *Regulations* and this *Code* to remedy the situation in respect of *Users* whose *plant* does not perform to the standards specified in this clause 2.4.1.

2.4.2 Harmonic Distortion

2.4.2.1 Harmonic Voltage Distortion

A *User* must ensure that the level of harmonic current at each of its *connection points* resulting from non-linearity commutation of power electronic equipment or other effects do not cause the contribution to the level of effective harmonic *voltage* imposed upon any other *User* to exceed 30% of the limits set out in Table 2.1 for *voltage* levels less than 66kV, and Tables 2.2 and 2.3 for *voltage* levels 66kV and above.

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 Tables 2.1, 2.2 and 2.3, as applicable.

Responsibility of *Western Power* for harmonic *voltage* distortion outside 100% of the limits specified in Tables 2.1, 2.2 and 2.3 must be limited to harmonic *voltage* distortion caused by *network* assets and the pursuit of all measures available under the *Regulations* and this *Code* to remedy the situation in respect of *Users* whose *plant* does not perform to the standards specified in this clause 2.4.2.1.

Table 2.1
Harmonic Voltage Distortion Limits (%) for Voltage Levels <66kV

Category	*Voltage* Limit (%)
Individual odd harmonics	4
Individual even harmonics	2
Total harmonic distortion	5

Table 2.2
Odd Harmonic *Voltage* Distortion Limits (%) for *Voltage* Levels ≥66kV

Harmonic Order (n)	*Voltage* Limit (%)
3	1.0
5	0.9
7	0.9
9	0.8
11	0.8
13	0.7
15	0.6
17	0.5
19	0.5
21	0.4
23	0.4
25	0.3
27-49	0.2
Total (odd + even)	1.5

Table 2.3
Even Harmonic *Voltage* Distortion Limits (%) For *Voltage* Levels ≥66kV

Harmonic Order (n)	*Voltage* Limit (%)
2	0.5
4	0.5
6	0.4
8	0.4
10	0.4
12	0.4
14	0.3
16	0.3
18	0.3
20-50	0.2
Total (odd + even)	1.5

Notes to Tables 2.1, 2.2 and 2.3:

1. The individual harmonic distortion (U_n) is the r.m.s. value of a harmonic *voltage* of order n expressed as a percentage of the r.m.s. value of the fundamental.

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

$$U_t = \sqrt{\left(\sum_{n=2}^{n=50} U^2_n\right)}$$

and expressed as a percentage of the fundamental.

3. The harmonic distortion limits apply to each phase.

4. Intermittent harmonic *voltage* distortion is subject to the same limits as continuous harmonic *voltage* distortion.

5. Existing (background) levels of harmonic *voltage* distortion are not included when assessing the harmonic contribution.

2.4.2.2 Non-Integer Harmonic Distortion

Each *User* must ensure that the level of non-integer harmonic current at each of its *connection point*s resulting from non-linear commutation of power electronic equipment or other effects does not cause an unacceptable level of harmonic *voltage* distortion on the *network*. Each non-integer harmonic should not exceed 30% of the limits specified in Table 2.1 for *voltage* levels less than 66kV and Table 2.3 for *voltage* levels 66kV and above, for the nearest even integer-harmonic. Total harmonic *voltage* distortion including these non-integer harmonic contributions should not exceed 30% of the limits for total harmonic *voltage* distortion specified in Table 2.1 for *voltage* levels less than 66kV and Table 2.3 for *voltage* levels 66kV and above.

Users must ensure that all their *plant* and equipment is designed to withstand without damage or reduction in life expectancy 100% of the limits (including non-integer harmonics) as specified in Tables 2.1, 2.2 and 2.3, as applicable.

Responsibility of *Western Power* for harmonic *voltage* distortion outside 100% of the limits (including non-integer harmonics) specified in Tables 2.1, 2.2 and 2.3 must be limited to harmonic *voltage* distortion caused by *network* assets and the pursuit of all measures available under the *Regulations* and this *Code* to remedy the situation in respect of *Users* whose *plant* does not perform to the standards specified in this clause 2.4.2.2.

2.4.2.3 Voltage Notching

Voltage notching caused by a *User's facilities* is acceptable provided that:

a) the limiting values of harmonic *voltage* distortion as described in clause 2.4.2.1 are not exceeded;

b) the maximum depth of the notch (refer to Figure 2 of *Australian Standard* AS2279, Part 2), that is, the average of start notch depth and end notch depth, must not exceed 20% of the nominal fundamental peak *voltage*; and

c) the peak amplitude of oscillations due to commutation at the start and end of the *voltage* notch (refer to Figure 2 of *Australian Standard* AS2279, Part 2) does not exceed 20% of the nominal fundamental peak *voltage*.

Users must ensure that all their *plant* and equipment is designed to withstand without damage or reduction in life expectancy the limits as specified in this clause 2.4.2.3.

Responsibility of *Western Power* for *voltage* notching outside the limits specified in this clause 2.4.2.3 must be limited to *voltage* notching caused by *network* assets and the pursuit of all measures available under the *Regulations* and this *Code* to remedy the situation in respect of *Users* whose *plant* does not perform to the standards specified in this clause 2.4.2.3.

2.4.2.4 Harmonic Current Distortion

The harmonic current distortion limits apply to each phase and are not to be exceeded by a *User* at each of its *connection points*. Any induced noise interference to telecommunications lines by the *User's load* due to harmonic currents is not acceptable and the *User* is required to reduce the level of harmonic currents so as to contain such interference to limits considered acceptable by the telecommunication network operator. The *User's load* should not cause any harmonic resonance in other *Users'* systems or the *Western Power network*.

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 Tables 2.4, 2.5 and 2.6, as applicable.

Responsibility of *Western Power* for harmonic current distortion outside 100% of the limits specified in Tables 2.4, 2.5 and 2.6 must be limited to harmonic current distortion caused by *network* assets and the pursuit of all measures available under the *Regulations* and this *Code* to remedy the situation in respect of *Users* whose *plant* does not perform to the standards specified in this clause 2.4.2.4.

(a) Odd Harmonic Currents

The harmonic current, flowing between any *User* and that *User's connection point*, which corresponds to any of the odd numbered harmonic orders, up to 49, shall not exceed the limits specified in Table 2.4 for that harmonic order.

Table 2.4
Odd Harmonic Current Limits

Voltage (l-l, kV)	Current Limit (amps)
<66	E ÷ 0.4n
≥66	E ÷ 13n

Notes for Table 2.4:

1. E = line to line *voltage* in kV.

2. n = harmonic order.

3. The current limit is rounded up to the nearest 0.1 amps. The minimum current limit is 0.2 amps.

4. Signal analysers should measure *frequencies* up to the 50th harmonic order.

(b) Even Harmonic Currents
The harmonic current, flowing between any *User* and that *User's connection point*, which corresponds to any of the even numbered harmonic orders, up to 50, shall not exceed the limits specified in Table 2.5 for that harmonic order.

Table 2.5
Even Harmonic Current Limits

Voltage (l-l, kV)	Current Limit (amps)
<66	E ÷ 1.2n
≥66	E ÷ 39n

Notes for Table 2.5:

1. Refer to notes for Table 2.4.

(c) Total Harmonic Current Distortion
The total harmonic current distortion shall not exceed the limits specified in Table 2.6.

Table 2.6
Total Harmonic Current Distortion Limits

Voltage (l-l, kV)	Current Limit (amps)
<66	E ÷ 0.8
≥66	E ÷ 26

Notes for Table 2.6:

1. E = line to line *voltage* in kV.

2. The current limit is rounded up to the nearest 0.1 amps. The minimum current limit is 0.2 amps.

3. Signal analysers should measure *frequencies* up to the 50th harmonic order.

2.4.2.5 Direct Current

User's plant and equipment shall comply with the requirements on direct current components as stipulated in clause 3.12 of *Australian Standard* AS3100. In particular, the direct current in the neutral caused by the *User's plant* and equipment shall not exceed 120mA.h per day.

Users must ensure that all their *plant* and equipment is designed to withstand without damage or reduction in life expectancy the limits as specified in this clause 2.4.2.5.

Responsibility of *Western Power* for direct current in the neutral outside the limits specified in this clause 2.4.2.5 must be limited to direct current in the neutral caused by *network* assets and the pursuit of all measures available under the *Regulations* and this *Code* to remedy the situation in respect of *Users* whose *plant* does not perform to the standards specified in this clause 2.4.2.5.

2.4.3 Voltage Unbalance

A *User* shall not cause the *voltage* unbalance factor at each of its *connection points* to increase from the level that existed prior to the *connection* of the *User* by more than 30% of the limits specified in Table 2.7.

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 2.7.

Responsibility of *Western Power* for *voltage* unbalance outside 100% of the limits specified in Table 2.7 must be limited to *voltage* unbalance caused by *network* assets and the pursuit of all measures available under the *Regulations* and this *Code* to remedy the situation in respect of *Users* whose *plant* does not perform to the standards specified in this clause 2.4.3.

Table 2.7
Voltage Unbalance Factor Limits (%)

Time Period	*Voltage* Unbalance Factor (%)
Continuous	1.0
5 minutes	1.5
Instantaneous	3.0

Notes to Table 2.7:

1. The 5 minute time period restriction means that an increase in the *voltage* unbalance factor of up to 0.45% (30% of 1.5) is permissible for an aggregate of up to 5 minutes in any 30 minute period.

2. The instantaneous value refers to the largest VUF recorded.

3. The 30% proportion is based on an allowance for existing *voltage* unbalance and future *voltage* unbalance sources.

For voltage levels 66kV and above, the *voltage* unbalance factor (VUF) is defined as:

$$VUF = (V_2 \div V_1) \times 100\%$$

where:

V_2 = negative phase sequence component of *voltage*; and

V_1 = positive phase sequence component of *voltage*.

The *voltage* unbalance factor must be determined accurately for *voltage* levels 66kV and above. Appropriate measuring/analysis methods shall be used to determine V_1 and V_2.

For voltage levels less than 66kV, the following voltage unbalance factor definition may be applied:

$$VUF = (Max\Delta V \div AvgV) * 100\%$$

where:

AvgV is the numerical average of the three individual phase-to-phase voltage values (measured simultaneously); and

MaxΔV is the maximum difference between any of the three phase-to-phase voltage values (measured simultaneously) and AvgV.

2.4.4 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.

2.5 STABILITY

Users must cooperate with *Western Power* to achieve stable operation of the *transmission networks* and must install emergency controls as reasonably required by *Western Power*. The cost of installation, maintenance and operation of the emergency controls must be borne by the *User*.

Each of the stability criteria stated in clauses 2.5.1, 2.5.2, 2.5.3 and 2.5.4 must be satisfied under the worst credible system *load* and *generation* pattern, and the most severe *credible contingency event* arising from either a *single credible contingency event* at up to 100% *peak load* or a double *credible contingency event* at up to 80% *peak load* (double *credible contingency event*s to be considered in accordance clauses 2.7 and 2.8).

2.5.1 Transient Stability

2.5.1.1 Transient Stability Criteria

(a) Transient stability is based on the relative rotor angle swing between two or more groups of synchronous machines when subjected to a disturbance. Relative rotor angle swings in excess of 90° may lead to the situation where the rotor angle does not return and increases beyond 180°, resulting in pole slipping or synchronous instability. Transient stability of the *power system* must be maintained. To ensure transient stability is maintained, due consideration during system studies must be given to the following:

(1) the maximum allowable relative rotor angle swing between any two or more groups of *generators* on the *network* shall not exceed 180° (after allowing for a safety margin consistent with *good electricity industry practice*);

(2) the transient *voltage* dip limit as specified in clause 2.5.3.3; and

(3) the possibility of delayed clearance of faults on the *network*.

(b) The most severe disturbance is to be selected from the following fault types to determine the stability of the *power system* (with due regard to be taken of reclosing onto a fault):

(1) a three-phase-to-earth fault;

(2) a single-phase-to-earth fault cleared by *backup protection* or high-speed single-phase auto-reclosing; and

(3) sudden *disconnection* of any *plant*, including a *generating unit*.

2.5.1.2 Critical Fault Clearance Time

One of the major factors affecting transient stability is the *fault clearance time*. The *critical fault clearance time* is the longest time that a fault can be allowed to remain on the *power system* to ensure that transient instability does not occur. *Critical fault clearance times* should be established for the various fault types at key locations. *Protection* must then be installed to ensure that the *critical fault clearance times* are achieved.

2.5.2 Dynamic Stability

(a) All electromechanical oscillations resulting from any small or large disturbance in the *power system* must be well damped and the *power system* must return to a stable operating state.

(b) The damping ratio of the oscillations should be at least 0.5. For interarea oscillation modes, lower damping ratios may be acceptable but the halving time of such oscillations should not exceed five seconds.

(c) If oscillations do not comply with clause 2.5.2(b), then appropriate measures must be taken to change the *power system* configuration and/or *generation dispatch* so as to eliminate such oscillations. Such measures must be taken by automatic means. *Users* who may cause subsynchronous or supersynchronous resonance oscillations must provide appropriate measures at the planning and design stage to prevent the introduction of this problem to the *Western Power power system* or other *Users'* systems.

2.5.3 Voltage Stability Limits

2.5.3.1 Temporary Over-Voltages:

Temporary AC over-*voltages* should not exceed the time duration limits given in Figure 2.1 unless specific designs are implemented to ensure the adequacy and integrity of equipment on *Western Power's power system* and other *Users'* systems plus the effects on *loads* have been adequately mitigated.

2.5.3.2 Transient Over-Voltages:

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

2.5.3.3 Transient Voltage Dip Criteria (TVD):

After clearing a system fault the *voltage* should not drop below 75% and shall not be below 80% for more than 0.4 seconds during the power swing that follows the fault. The maximum transient voltage dip is 25% and the maximum duration of *voltage* dip exceeding 20% is 20 cycles (400ms). Refer to Figure 2.2 for further details.

2.5.3.4 Voltage Stability:

All necessary steps should be taken to ensure that *voltage* collapse does not occur for the most onerous *outage* of a *transmission element* under credible *generation* schedules under full *load* conditions. It should also be assumed that 3% of the installed *capacitors* are unavailable. *Voltage* collapse is associated with a deficit of *reactive power*. Adequate reactive reserves based on *power system* studies should be provided (see notes below).

Notes:

1. The system *load* to be used in studies is the 1 in 10 year probability forecast.

2. All *generation* with the exception of one unit is to be taken as available with none of the MVAr limits to be exceeded.

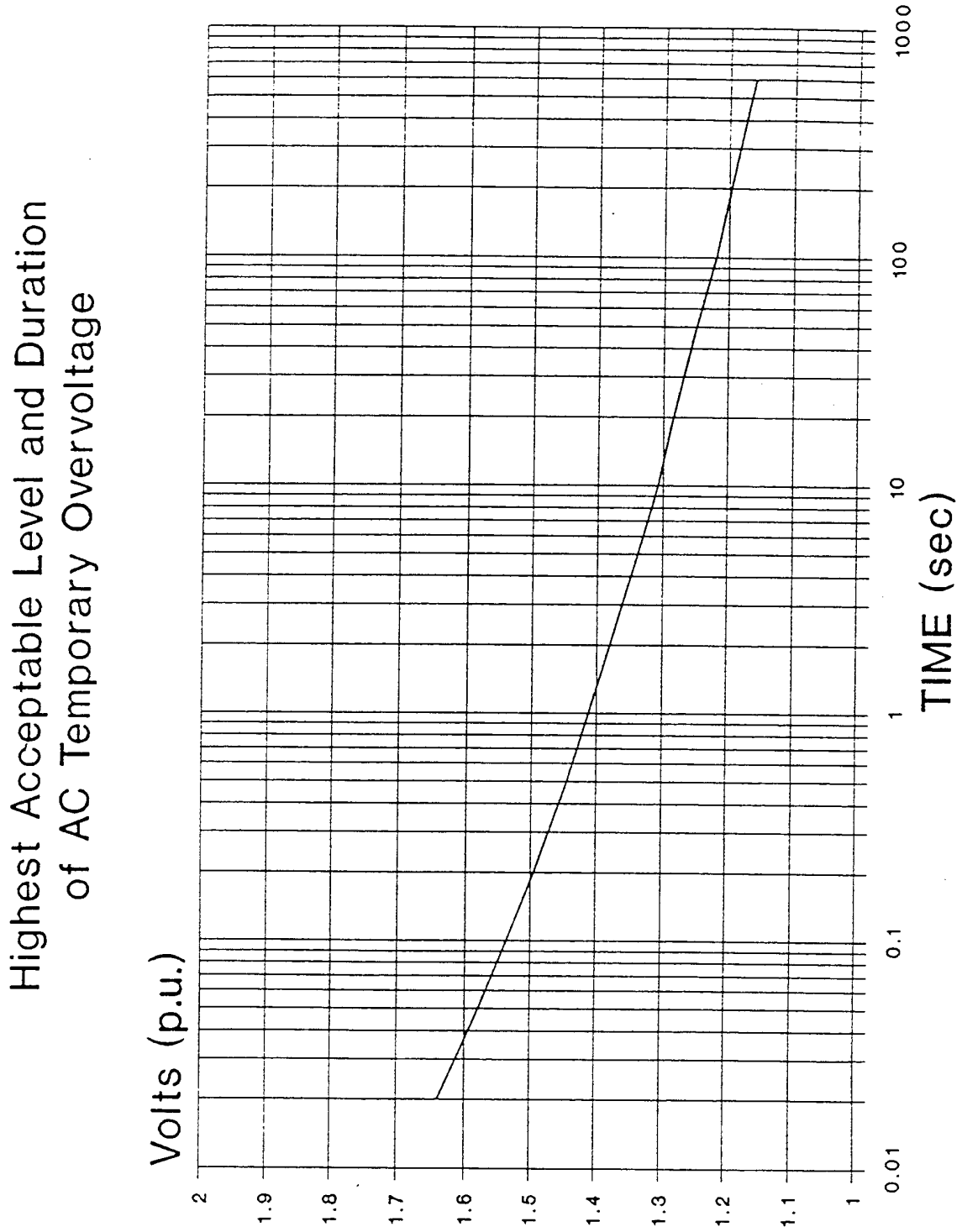
Adequate damping of *voltage* oscillations should be provided to ensure that all oscillations of fundamental and harmonic *frequency* are well damped as required in clause 2.5.1. Subsynchronous and supersynchronous oscillations should be damped accordingly within five seconds or otherwise appropriate countermeasures are taken within two seconds to damp the oscillations or remove the affected *plant* from the *power system*.

2.5.4 Frequency Stability Limits

To cover for a loss of a *generating unit* from the *power system* two measures will be applied to arrest the fall in *frequency* following the loss of *generation* and to return the *frequency* to within normal operating levels as specified in clause 2.2:

1. spinning reserve (the use of fast response *plant*); and
2. under-*frequency load shedding* (UFLS).

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



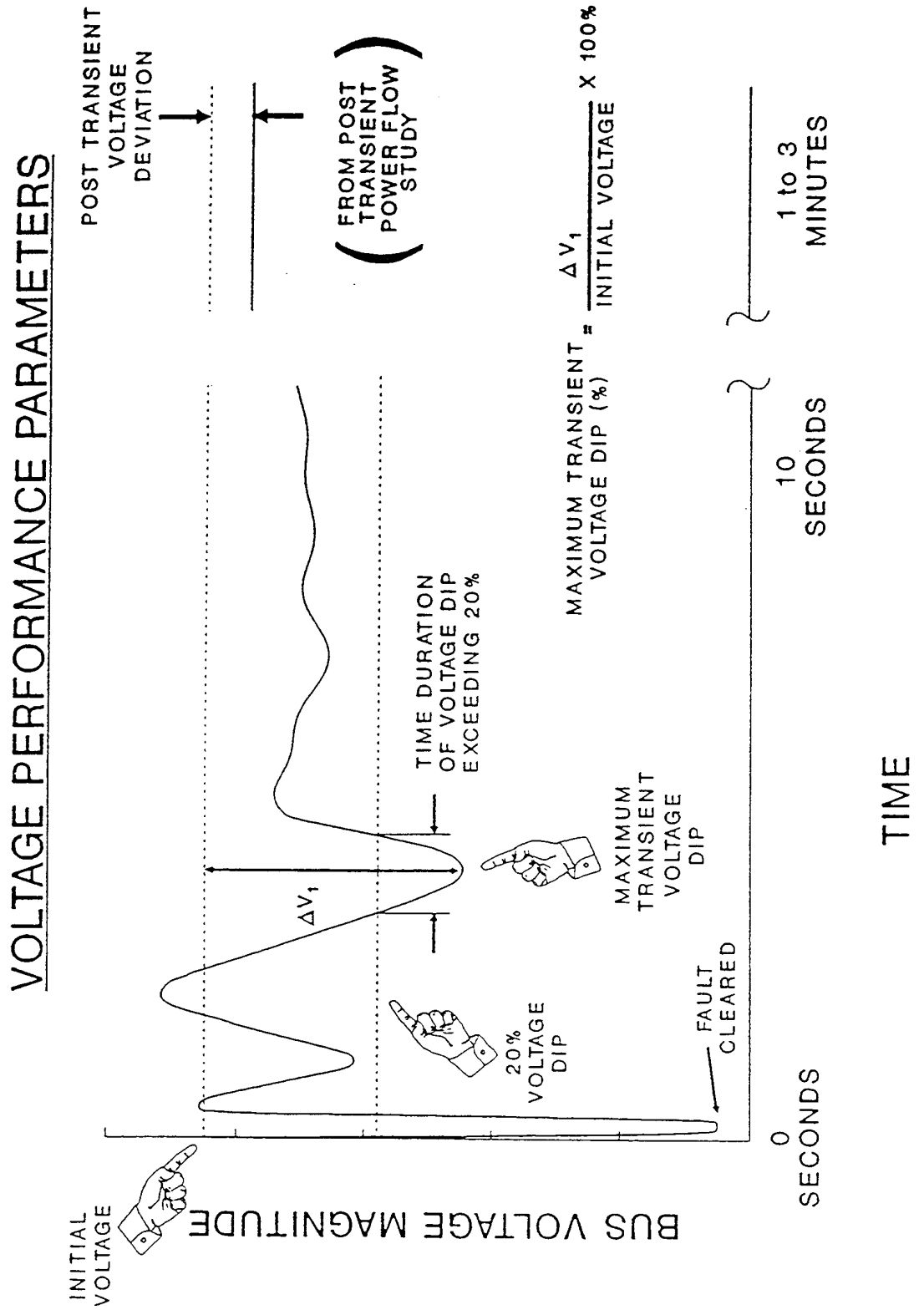


Figure 2.2 - Voltage Performance Parameters

2.6 *LOAD SHEDDING FACILITIES*

2.6.1 *Load* to be Available for *Disconnection*

It is a requirement for *power system security* that 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 network*. The settings of a *load shedding* scheme shall be in accordance with the existing settings outlined in clause 2.6.3, unless otherwise agreed by *Western Power*.

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

2.6.2 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*.

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

The present settings for the *South West Transmission Network* under-*frequency load shedding* scheme are given in Table 2.8 and for the *North West Transmission Network* under-*frequency load shedding* scheme are given in Table 2.9.

Switchable *capacitor bank*s at *substation*s should also be shed in accordance with Table 2.8 and Table 2.9.

Table 2.8
Under-*Frequency Load Shedding* Scheme Settings for the *South West Transmission Network*

Stage	*Frequency* (Hz)	Time Delay (sec)	*Load* Shed (%)	Cumulative *Load* Shed (%)	Capacitor shed (%)	Cumulative Capacitor Shed (%)
1	48.75	0.4	10	10	10	10
2	48.50	0.4	14	24	14	24
3	48.25	0.4	15	39	15	39
4	48.00	0.4	12	51	12	51
5	47.75	0.4	12	63	24	75
6	47.50	0.4	12	75	25	100

Table 2.9
Under *Frequency Load Shedding* Scheme Settings for the *North West Transmission Network* (*Western Power load*s only)

Western Power				
Stage	Freq. (Hz)	Time Delay (sec)	*Load* Shed (%)	Capacitor Shed (%)
1	49.00	0.5	15	0
2	48.75	0.5	15	20
3	48.25	0.5	15	40
4	48.00	0.5	15	20
5	47.50	0.5	15	20

2.7 RELIABILITY OF THE TRANSMISSION NETWORK

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

- N,
- N-1 or,
- N-2.

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

A section of a *network* designed to the N-1 criteria 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.

The N-2 criterion is usually applied only to the most important *network* elements (such as the largest system generator(s) or transmission grid lines). N-2 criteria 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 remainder of the *network* will be designed to the N-1 criteria with the exception of radial feeds to remote *power system loads* which are normally designed to the N criteria. The *reliability* criteria adopted for each *sub-network* may be qualified by a risk/benefit analysis and other considerations such as capital investment priorities, social needs, the environment and land use. In some cases this may mean a more 'lenient' technical solution is permitted, while in other cases a stringent performance criteria may be applied.

The *reliability* criteria in this clause 2.7 apply only to the *electricity transmission 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 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*.

2.8 CONTINGENCY CRITERIA FOR THE TRANSMISSION NETWORK

For the *network* designed to operate with the N-1 criterion the *network* must be capable of withstanding the loss of any single component at any *load* level and for any generation schedule.

The N-1 contingency criterion applies to:

1. All aspects of the steady-state criteria in clause 2.9.
2. All aspects of the stability criteria in clause 2.5.
3. All aspects of the *quality of supply* criteria in clause 2.4.

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 2.10 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 2.9.
2. All aspects of the stability criteria in clause 2.5.

Table 2.10
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*
busbar maintenance and second *busbar* loss
circuit breaker maintenance and *busbar* loss
transmission line maintenance and *transformer*

2.8.1 Stuck Breaker Criterion

For stuck breakers initiated by line or *transformer* faults, the operation of the *transmission sub-network* designed to the N-2 criteria 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.

2.9 STEADY STATE CRITERIA

Each of the steady state criteria should be satisfied for the contingency criteria in clause 2.8 of this *Code* (N-1 and N-2 criteria):

2.9.1 Steady State Voltage Limits

The steady state *power system voltage* should not exceed the design limits specified in clause 2.3 of this *Code.*

Step changes in *voltage* should not exceed the limits specified in Table 2.11.

Table 2.11
Step - Change Voltage Limits

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

2.9.2 Thermal limits:

The thermal ratings of the *transmission 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.

2.9.3 Fault limits:

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

2.9.4 Generating limits:

Limits to the VAr generation and absorption capability of generating *plant*, gas turbines and reactive compensation plant such as *static VAr compensators* are not be exceeded.

2.10 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.

2.11 ENVIRONMENTAL CRITERIA

As part of the planning process the following criteria should be administered for any new developments and *facilities* which may have a significant impact on the environment:

2.11.1 Social Issues

Inform and consult with relevant public bodies, community interest groups and the general public.

2.11.2 Land-use Considerations

Avoid where economically possible the use of land where conflicting uses or potential uses exist.

3. TECHNICAL REQUIREMENTS OF *USER*S' *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 agreement*.

3.2 CONDITIONS FOR *CONNECTION* OF *GENERATORS*

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*. All costs associated with these studies, including studies to obtain any necessary optimal settings for the *generating unit* and its controls shall be borne by the *User*. The *User* shall be responsible for all costs associated with the installation, performance verification, parameter tuning and model validation of any additional equipment identified in the studies.

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 *User* will be responsible for the cost of any *plant* upgrades required at its *facilities* as a result of changing *power system* conditions.

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 agreement*, the *User* shall be responsible for remedying the problem at its cost.

3.2.1 Technical Characteristics

a) If required by *Western Power*, a *User* must ensure that new *synchronous generating units* have a short circuit ratio of not less than 0.5 if necessary to limit the reduction in *power transfer capabilities* that are determined by transient stability considerations.

b) A *User* must ensure that its *generating unit(s)* comply with the requirements advised by *Western Power* as to the minimum subtransient reactance that the *generating unit* may have if necessary to control fault levels on the *transmission network*.

c) A *User* must ensure that its *generating unit(s)* satisfy *Western Power's* reasonable requirements to ensure stability of the *electricity transmission network* and maintain *power transfer capabilities*. These requirements will have an impact on the generator, governor and excitation system parameters, including the inertia constant, of the *generating unit*.

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*;

h) Interlocking arrangements;

i) *Metering installations* as described in Section 6;

j) *synchronising facilities*;

k) under *frequency load shedding* and islanding schemes; and

l) 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-3 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 Attachment 3 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

(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.

(2) Each *asynchronous generating unit* must be compensated by shunt capacitors so as to *supply reactive power* output to the *network* at the *connection point* such that the lagging *power factor* is less than or equal to 0.95 coincident with rated real power output. 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.

(b) In the event that the *power factor* capabilities specified in (a)(1) and (a)(2), as applicable, cannot be provided, the *User* must reach a commercial arrangement under the *access agreement* 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 agreement* 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 *non-synchronous generators* the contributions to *quality of supply* must be not less than that required to be provided by *Users* as defined in Clause 2.4.

3.2.4.3 Generating Unit Response To Disturbances In The *Power System*

The following are design requirements for *generating units*. *Network* performance requirements are detailed in Section 2 of this *Code.*

a) A *generating unit*, and the *power station* in which the *generating unit* is located, must be capable of continuous uninterrupted operation within the *frequency* limits specified in clause 2.2.

b) A *generating unit*, and the *power station* in which the *generating unit* is located, must be capable of continuous uninterrupted operation during the occurrence of the range of *voltage* variation conditions permitted by Clause 2.3, including the *voltage* dip caused by a *transmission network* fault which causes *voltage* at the *connection point* to drop to zero for up to 1.0 second 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 *voltage*, and a subsequent period of three minutes in which the *voltage* may vary within the range 90-110% of the 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 agreement* 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 agreement*.

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 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 47Hz to 52Hz (In the case of operation below 47Hz but at or above 45Hz, all *generators* shall remain *connected* to the *Western Power network* for a period of at least 2 seconds - refer to clause 2.2);

(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; and

(8) reverse 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 System*s 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.

3.2.4.10 Generator T*ransformer* Tapping

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

3.2.4.11 Tripping Of *Generating Units* And *Associated Loads*

Unless otherwise agreed by *Western Power*, the tripping of a *User's generating unit* which is *connected* to the *transmission network* will require the intertripping of *associated loads*

within 0.2 seconds, except where the *User* has contracted for the provision of *standby power* and that *standby power* is available at the time of the tripping of the *generating unit*.

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 (double pole)
(2) remote *generation load* control on/off
(3) *generating unit* operating mode
(4) governor limiting operation
(5) *connection* to the *transmission network*

(b) Alarms

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

(c) Measured Values

(1) Gross *active power* output of each *generating unit*
(2) Net station *active power* import or export at each *connection point*
(3) Gross *reactive power* output of each *generating unit*
(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

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

3.2.5.2 Communications Equipment

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*.

A *User* must provide communications paths (with appropriate redundancy) between the *RME* 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*. Communications systems between this communications interface and the relevant *control centre* must be the responsibility of *Western Power* unless otherwise agreed. The cost of the communications systems must be met by the *User*, unless otherwise determined by *Western Power*.

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. The costs of the equipment must be recovered through the charge for *connection*.

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 Governor System

All *generating units* must have an automatic governor system. These governor 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.

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.

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 agreement*, and the *User* must use reasonable endeavours to ensure that the *generating unit* responds in accordance with that agreement. 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.

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.

The *frequency* response and deadband values may be varied with the approval of *Western Power* under the *access agreement*.

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 agreement* and advised to *Western Power*. 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.

When operating in a mode where the *generating unit* is insensitive to *frequency* variations , a deadband of not greater than 0.25 Hz must be applied to ensure that the *generating unit* will respond for *frequency* excursions outside the *normal operating frequency band.*

The *governor system* of a *generating unit* must be adjusted for stable performance under all operating conditions with adequate damping. Adequate damping would be indicated where for a step change in the governor speed feedback signal the *load* change transient oscillations have a minimum damping ratio of 0.5 and the steady state response is within plus or minus 20 per cent of the ideal response having regard to *load*ing rates and deadband.

The structure and parameter settings of all components of the governor control equipment, including the speed/*load* controller, actuators (for example hydraulic valve positioning systems), valve flow characteristics, limiters, valve operating sequences and steam tables for steam turbine (as appropriate) 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 *governor system* for all expected modes of governor operation. These parameters must not be varied without prior approval of *Western Power*.

3.2.5.4 Excitation Control System

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*);

(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. A.C. 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* stabiliser 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 a.c. exciter, rotating rectifier and *static excitation system*s:

Table 3.1
Excitation System Performance Requirements

Performance Item	Units	Static Excitation	A.C. 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 *synchronised* 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 *unsynchronised* 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
Negative field *voltage*	-	yes	no	3

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)

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. Negative field current is not required (unless determined by system studies).

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

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 cost of altering the settings and verifying subsequent performance must be borne by the *User*, provided alterations are not made more than once in each 18 months for each *generating unit*. If more frequent changes are requested the person making that request must pay all costs on that occasion.

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 co-ordinated 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*

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 network*.

Prior to the initial *synchronisation* of the generating unit(s) to the *transmission 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 3.3.6.

3.3 CONDITIONS FOR *CONNECTION* OF *LOAD*S

The following applies to the *connection* of *load*s to *transmission 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*.

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, *good electricity industry practice* and this *Code*, including, but not limited to, the *quality of supply* standards as specified in clause 2.4.

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 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 *User* will be responsible for the cost of any *plant* upgrades required at its *facilities* as a result of changing *power system* conditions.

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 agreement*, the *User* shall be responsible for remedying the problem at its cost.

3.3.3 *User Protection System*s 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 *Connection Point* For A *User*

*Connection point*s between a *User's* facility and a *transmission network* will be defined in the *access agreement*.

3.3.5 *Power Factor* Requirements

Power factor ranges to be met by *Users* for their *load*s 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

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 in the table over 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 network*. Adequate filtering *facilities* should be provided if necessary to absorb any excessive harmonic currents.

3.3.6 Design Requirements For *User*s' *Substation*s

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, and must reduce step and touch potentials to safe levels.

(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 3.3.6(j).

(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) 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-3 standing with the Institution of Engineers, Australia, unless otherwise agreed.

3.3.7 *Load Shedding Facilities*

Users are required to provide automatic interruptible *load* to *Western Power* in accordance with clause 2.6.

3.3.8 Monitoring and Control Requirements

3.3.8.1 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 *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) relevant circuit breakers open/closed (double pole) within the *plant*
(2) relevant isolators within the *plant*
(3) *connection* to the *transmission network*

(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*

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

3.3.8.2 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. The cost of the communications systems must be met by the *User*, unless otherwise determined by *Western Power.*

3.3.9 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*. *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 Safety of People

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.

3.4.1.2 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.

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.

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 Availability of *Protection*

A *User* must ensure that all equipment is protected by two independent *protection*s and 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.

3.4.2.3 Duplication of *Protection*

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, no cross *connection*s are to be made between them. 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*.

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.

Table 3.3
Standard *fault clearance time*s (msec) - *South West Transmission Network* and *North West Transmission Network*

		No CB Fail	CB Fail
220kV and above	Local	120	370
	Remote	180	420
66kV and 132kV	Local	150	400
	Remote	200	450

For *voltage*s below 66kV in both the *South West Transmission Network* and *North West Transmission Network*, the clearance times will be as specified by *Western Power* in the *access agreement*.

Where *critical fault clearance time*s exist, *User*s shall maintain a record of design *fault clearance time*s 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 Lines at or Below 132kV Standard *fault clearance time*s (msec) -
South West Transmission Network & North West Transmission Network

		No CB Fail	CB Fail
132kV	Local	150	400
	Remote	400	650
66kV	Local	1000	>1000
	Remote	>1000	>1000

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.

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 *Interconnection*s 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.

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, 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 the cost of 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*. The *user* shall pay *Western Power*'s reasonable costs associated with the witnessing of the commissioning tests.

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* is required to 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 *Transformer*s

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* at the *User*'s cost.

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 3.3.8.1, 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. *Protection* shall also be provided to detect and clear, without system instability, faults, in accordance with clauses 2.5 and 2.8.

All other faults shall be similarly detected and cleared, though it is not expected that system stability would be maintained.

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 agreement*.

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 otherwise agreed by *Western Power*, the *User* shall provide *facilities* to initiate islanding in the event of their system drawing more than the agreed MW/MVAr demands from the *Western Power power system* for a specified time.

*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. Where a *User* does not wish to meet the requirements of clause 2.2, 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* (e.g. on some radial transmission lines). 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*.

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 *Regulations*, or the *Code*, or an *access agreement*, or an *ancillary services agreement*; 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 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 *Code* or *access agreement* or *ancillary services agreement*, 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 this *Code* or an *access agreement* enters into a confidentiality undertaking in favour of the *User* in a form reasonably acceptable to the *User* prior to gaining such access.

g) The costs of inspections under this clause 4.1.1 must be borne by the *User* if the suspected non-compliance is later proved by tests.

h) 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).

i) 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).

j) 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 this *Code* 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) must reimburse the owner of any such equipment or goods for reasonable costs and expenses suffered or incurred by the owner due to loss or damage to any such equipment or goods caused by the *User*.

4.1.2 Right Of Inspection And Testing

(a) If *Western Power* has reasonable grounds to believe that equipment owned or operated by a *User* may not comply with the *Regulations, Code* or the *access agreement, 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 time agreed by *Western Power.*

(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) The cost of tests requested under clause 4.1.2(a) must be borne by *Western Power,* unless the equipment is determined by the tests not to comply with the relevant *access agreement, Code* and/or the *Regulations,* in which case all reasonable costs of such tests must be borne by the owner of that equipment.

(e) 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.

(f) 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 *Regulations*, this *Code* or the relevant *access agreement* 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 agreement*. 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 are detailed in Attachment 5. Other tests, if reasonably necessary, may be specified by *Western Power*, and *Users* will be advised accordingly.

(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 agreement.*

(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 agreement* 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 agreement, 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 *Code 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 agreement* 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.

c) Each *User* shall pay *Western Power*'s reasonable costs and shall bear its own costs of conducting tests under this clause 4.1.4.

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 agreement*, 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*.

(h) Each *User* must bear its own costs associated with tests conducted under this clause 4.1.6 and no compensation is to be payable for financial losses incurred as a result of these tests or associated activities.

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 *governor 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 network tests* to assess the technical performance of the *transmission 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 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*.

(h) Each *User* is to bear its own costs of conducting tests under this clause 4.1.7 and no compensation is to be payable for financial losses incurred as a result of these tests or associated activities.

(i) If *Western Power* has initiated the tests as part of a series of periodic *power system* performance assessment studies, then the costs of the studies will be borne by *Western Power*. If the tests demonstrate the need for a *User* to install additional equipment in order to maintain or enhance *power system* performance in accordance with this *Code*, then the *User* will be responsible for the cost of installing the additional equipment.

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, this *Code*, the *Regulations* and any relevant *access agreement* prior to or within an agreed time after being *connected* to a *transmission 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*.

(f) The *User* must pay *Western Power*'s reasonable costs associated with the assessment of the parameter settings under this clause 4.2.3.

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.

(e) The *User* must pay *Western Power*'s reasonable costs associated with the assessment of the commissioning program under this clause 4.2.4.

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 *Regulations*, this *Code*, the relevant *access agreement*, all relevant standards, all statutory requirements and *good electricity industry practice*. The statement shall have been certified by a Chartered Professional Engineer with NPER-3 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 this *Code* or the relevant *access agreement* 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 this *Code* or the relevant *access agreement* 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 this *Code*.

(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*.

(g) The *User* must pay *Western Power*'s reasonable costs associated with the witnessing of commissioning tests under this clause 4.2.5.

4.3 *DISCONNECTION* AND RE*CONNECTION*

4.3.1 Voluntary D*isconnection*

(a) Unless agreed otherwise and specified in a *access agreement*, 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 agreement*, to require voluntary permanent *disconnection* of its equipment from the *power system* in which case appropriate operating procedures necessary to ensure that the *disconnection* will not threaten *power system security* must be implemented in accordance with clause 4.3.2.

(c) The *User* must pay all costs directly attributable to the voluntary *disconnection* and *decommissioning*.

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 agreement* 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 agreement* 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 agreement.*

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.

4.3.4 *Disconnection* Due To Breach Of An *Access Agreement*

a) Subject to the relevant provisions of the *Regulations*, *Western Power* may dis*connect* a *User's facilities* from a *transmission network* if in *Western Power's* reasonable opinion, the *User* has breached a term of the *access agreement* and such breach poses a threat to *power system security*. In such circumstances *Western Power* will not be

liable in any way for any loss or damage suffered or incurred by the *User* by reason of the *disconnection* and *Western Power* will not be obliged for the duration of the *disconnection* to fulfil any agreement to convey electricity to or from the *User's facility.*

b) A *User* must not bring proceedings against *Western Power* to seek to recover any amount for any loss or damage described in clause 4.3.4(a).

c) Transmission charges must be paid by a *User* whose *facilities* have been *disconnected* under this clause 4.3.4 as if any *disconnection* had not occurred.

4.3.5 *Disconnection* During An Emergency

Where *Western Power* may *disconnect* a *User's facilities* during an emergency under this *Code* 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 network* at a reasonable cost to the *User* as soon as practicable if:

(a) a breach of the *Regulations*, *Code* or *access agreement* giving rise to *disconnection* has been remedied; or

(b) where the breach is not capable of remedy, compensation has been agreed and paid by the *User* to the affected parties or, failing agreement, the amount of compensation payable has been determined in accordance with the Dispute Resolution and *Electricity Referee Regulations* and that amount has been paid; or

(c) where the breach is not capable of remedy and the amount of compensation has not been agreed or determined, assurances for the payment of reasonable compensation have been given to the satisfaction of *Western Power* and the parties affected; or

(d) 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 *Code*, 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* PRINCIPLES

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

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 within the *normal operating frequency band* (49.8Hz to 50.2Hz in the *South West Transmission Network* and 49.6Hz to 50.4Hz in the *North West Transmission Network*), except for brief excursions within the *normal operating frequency excursion* band (49.5Hz to 50.5Hz in the *South West Transmission Network* and 49.25Hz to 50.75Hz in the *North West Transmission Network*) as specified by this *Code*;

(b) the *voltage* magnitudes at all energised *busbars* of the *transmission network* are within the relevant limits set by *Western Power* in accordance with this *Code* and clause 2.3 of this *Code*;

(c) the current flows on all *transmission lines* of the *transmission 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 network* is such that the severity of any potential fault is within the capability of transmission circuit breakers 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 2.5.

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 2.8 of this *Code*) 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 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 agreement* between that *User* and *Western Power* provides otherwise; and
   (3) *Users* have provided automatic and/or manually *interruptible load* in accordance with their *access agreement* and this *Code*.

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 clauses 2.7 and 2.8 of this *Code*;
   (5) agreed *generation load constraints*;
   (6) *constraints* on the *transmission 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 plant* availability.

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 *satisfactory operating state* as soon as practical.

(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 agreements* or *ancillary services agreements,* to provide and maintain all required *facilities* consistent with both their *access agreement* 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 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 agreement*

(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 *Code* 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 this *Code* 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 agreements* 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 at their own cost. 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 *Regulations,* including through the provision of appropriate information to *Users* to the extent permitted by law and under this *Code*, 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 *Code* 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 *Regulations,* 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 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.

(e) In the event that *Western Power*, in its reasonable opinion for reasons of safety to the public, *Western Power* personnel, *User*s' equipment or *Western Power* equipment or for *power system security*, needs to interrupt *supply* to any *User*, *Western Power* will (time permitting) consult with the relevant *User* prior to executing that interruption.

(f) *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) All *User*s must co-operate with and assist *Western Power* in the proper discharge of the *Western Power power system security responsibilities*.

(b) All *Users* must operate their *facilities* and equipment in accordance with any reasonable *direction* given by *Western Power*.

(c) All *Users* must provide automatic *interruptible load* of the type described in clause 2.6. The level of this automatic *interruptible load* will be a minimum of 75% of their expected demand, or such other minimum *interruptible load* level as may be periodically determined by *Western Power* in accordance with clause 2.6.

(d) *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 this *Code* 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 speed *governor 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 *TRANSMISSION NETWORK VOLTAGE*S

5.5.1 *Transmission 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 network voltages*.

(b) *Western Power* must assess and determine the limits of the operation of the *transmission network* associated with the avoidance of *voltage* failure or collapse under *credible contingency event* scenarios.

(c) 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*.

(d) The determination referred to in clause 5.5.1(b) must include a review of the dynamic stability of the *voltage* of the *transmission network*.

(e) *Western Power* must use its reasonable endeavours to maintain *voltage* conditions throughout the *transmission 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 agreements*;
  (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) *shunt capacitors*;
  (5) *shunt reactors*;
  (6) 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 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 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 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* 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 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 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 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 2.5 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) at no cost to *Western Power*.

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 *transmission* 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 this *Code:*

(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 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* 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*

Subject to regulation 30 of the *Regulations* and *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*; 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*

(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 load*s

(a) Where, under the *Regulations* or this *Code*, *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 must ensure they have sufficient *facilities* available and operable for their own black start-up requirements.

5.8.9 Local black system procedures

(a) *User* 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 and Electricity Referee *Regulations*.

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 *ancillary services agreement* with another *User*, then the *local black system procedures* for that *User* must be consistent with this *Code* and their *access agreements*.

(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 *ancillary services agreement*, the relevant connection *agreement or Regulation.*

(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 *User*, a report of the review carried out must be provided by *Western Power* to the *User* advising of the circumstances requiring that action.

(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

A *User* must not, unless in the *User'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 *generating unit*, except:
- (1) in accordance with the procedures specified in this *Code* 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 this *Code* 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 *User's* reasonable opinion, the adjustment is urgently required to prevent material damage to the *User'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 this Code or procedures agreed with *Western Power*.

(c) *energise* a *connection point* in relation to a *User's generator 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 *Users* requiring *standby power*

(a) Any *User* requiring *standby power* from *Western Power* 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 regulation 31 of the *Regulations*.

(b) A *User* 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 *User's 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* not requiring *standby power* 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 *User 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

Operation, maintenance and extension planning and co-ordination shall be performed in accordance with regulation 31 of the *Regulations*.

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 network* operations

(a) *Western Power* must conduct or direct operations on the *transmission 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 network* in accordance with the requirements of the *Regulations*, this *Code*, any applicable *access agreement*, *ancillary services agreement*, and *Western Power*'s Electrical Safety Instructions and procedures.

(d) *Users* must ensure that *transmission 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 network*;

(2) *substation connected* to the *transmission 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 *Regulations*. 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 network.*

(d) For the purposes of the *Regulations* and this *Code*, 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* 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* 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*, *Western Power* must pay all reasonable costs incurred in complying with the request.

6 METERING

6.1 INTRODUCTION TO THE METERING SECTION

6.1.1 Application of the Metering Section

This section applies to all *Users* at any *tariff metering point* through which *energy* is transferred to or *energy* is taken from *Western Power's electricity transmission network*.

6.1.2 Purpose of Metering Section

(a) The purpose of this section is to set out the rights and obligations of *User*s and *Western Power*.

(b) This section sets out provisions relating to:

1) *tariff metering installations* used for the measurement of *active energy* and *reactive energy*, imported and/or exported;
2) *check metering installations*;
3) collection of *tariff metering data*;
4) provision, installation and maintenance of equipment;
5) accuracy of *tariff metering equipment;*
6) testing requirements;
7) security and rights of access to *tariff metering data and* equipment*; and*
8) provision of *tariff metering data*.

6.1.3 Principles Of Metering Section

The key principles adopted in this section are:

(a) each *connection point* must have a *tariff metering installation*;

(b) the type of *tariff metering installation* at each *tariff metering point* is to be determined by *Western Power* in accordance with the annual amount of *energy* passing through that *tariff metering point;*

(c) *Western Power* will have responsibility for the provision and installation of *tariff metering* unless the *User* elects to provide and install the *tariff metering*, other than the *tariff meters*, which will be provided and installed by *Western Power*;

(d) *Western Power*'s Metering & Testing Section will install the *tariff meters* or the *tariff metering*, and will commission and maintain the *tariff metering* on the basis of it being an independently certified *NATA* registered laboratory.

(e) *Western Power*'s Metering & Testing Section may offer to install a *check meter*, or *check meters*, or *check metering*, and commission and maintain *check metering* on behalf of the *User*.

(f) *Western Power* will own the *tariff metering installation* and the *User* will be required to make a non-refundable capital contribution to the cost of the installation.

(g) All costs associated with the auditing and maintenance of a *tariff metering installation* will be borne by the *User*.

(h) *Western Power* must ensure that the accuracy of each component of a *tariff metering installation* complies with its accuracy class.

(i) *energy data* is to be based on units of watthours *active energy* and varhours *reactive energy*;

(j) *Western Power* will make *tariff metering data* available to each *User*, subject to confidentiality requirements.

(k) The *tariff meters* used will make provision for signals comprising energy usage information to be available via volt free relay contacts at the *tariff metering location*.

(l) The specifications for the *tariff metering voltage* and *current transformers* will make provision for secondary *voltages* and currents to allow the *User* to readily install *check metering*, if required by the *User*.

(m) Historical *tariff metering data* is to be retained for a minimum of 7 years.

(n) *Western Power* will audit *tariff metering* when requested.

6.2 RESPONSIBILITY FOR METERING INSTALLATION

6.2.1 Responsibility of *Western Power*

(a) No later than 20 *business days* after receiving a request for the provision of a *tariff metering installation*, or a *tariff metering installation* and a *check metering installation* from a prospective *User*, *Western Power* shall provide a quotation and any conditions on which the offer is made and also advise the *User* of its right to provide and install certain *tariff metering* components in accordance with Attachment 4 and *Western Power's tariff metering specifications*.

(b) If the *User* accepts the offer, *Western Power* has the responsibility for the provision, installation, commissioning and maintenance of the *tariff metering* equipment in accordance with Attachment 4 and *Western Power's tariff metering specifications*.

6.2.2 *User* Elects To Provide And Install Certain Metering Components

(a) If the *User* does not accept the offer made by *Western Power* to provide a *tariff metering installation*, the *User* will be responsible for the provision and installation of the *tariff metering*, except for the *tariff meters* in accordance with Attachment 4 and *Western Power's tariff metering specifications* and the *check metering*, if required by the *User*.

(b) *Western Power* will provide and install the *tariff meters*, commission the installation and provide ongoing maintenance of the *tariff metering installation* in accordance with Attachment 4 and *Western Power's tariff metering specifications*.

6.2.3 Other Responsibilities

(a) *Western Power* must ensure that the *tariff metering installation* is provided, installed and maintained in accordance with Attachment 4 and *Western Power's tariff metering specifications*.

(b) The *User*, if providing and installing *tariff metering equipment*, must ensure that the equipment complies with Attachment 4 and *Western Power's tariff metering specifications* and that prior to installation, the equipment which is involved in measurement of energy, other than the *check meters*, is submitted to *Western Power* for testing for compliance with *Western Power's tariff metering specifications*.

6.3 METERING INSTALLATION ARRANGEMENTS

6.3.1 Metering Installation Components

(a) A *tariff metering installation* must comply with the requirements of the National Standards (Weight & Measures) Act in regard to being a measuring device which is used for trade or legal purposes.

(b) A *tariff metering installation* must:

1) contain a measuring device for *active* and *reactive energy* and a visible display of all *tariff metering data* as per AS1284;

2) be accurate in accordance with Attachment 4;

3) have electronic data transfer *facilities*;

4) be secure in accordance with *Western Power's tariff metering specifications*;

5) have electronic data recording *facilities* for *active* and *reactive* energy flows;

6) be capable of separately registering and recording energy import and export where bi-directional energy flows occur;

7) be capable of providing *tariff metering data* to a communication system; and

8) include a communication system for two way communications with *Western Power*.

(c) A *tariff metering installation* will consist of combinations of, but is not limited to, the following:

1) *current transformer*;
2) *voltage transformers*;
3) secure and protected wiring;
4) *tariff meter* panels on which the *tariff meters* and communication equipment are mounted;
5) series *tariff meters* (two off);
6) communication equipment such as modem, Public Switched Telephone Network connection, isolation, radio transmitter and receiver, data link, or power line carrier equipment;
7) test links and fusing;
8) energy and status signals;
9) summation equipment;
10) *tariff metering* enclosure;
11) marshalling boxes; and
12) *tariff metering* unit.

(d) The *tariff metering installation* is exclusively for *tariff metering* other than the provision of energy and status signals which may be provided to the *User* for other purposes.

6.3.2 Use of Meters

(a) *Tariff metering data* will be used by *Western Power* as the primary source of billing data.

(b) The readings of the series *tariff meters* will be averaged to obtain a reading.

(c) If the series *tariff meters* readings differ by more than 1%, then one of the readings will be discarded for the purpose of determining the reading.

(d) When readings differ by more than 1% and it is not self evident which reading is correct, a determination will be made by reference to *check metering*, if provided, or if not, by an on site audit.

(e) Where appropriate *check metering data* is available, it will be used if both *tariff meters* fail.

6.3.3 Metering Type and Accuracy

(a) The accuracy for a *tariff metering installation* and the requirements for a *tariff metering installation* which must be installed at each *tariff metering point* must be in accordance with Attachment 4 and *Western Power's tariff metering specifications.*

(b) A *check metering installation* is not required, but if provided by an *User* it may use the *voltages* and currents provided by the *tariff metering voltage transformers* and *current transformers*. The *tariff meter* or *tariff meters* will be of the same class as the

tariff meters. If the *User* elects to provide separate *current transformers* and *voltage transformers* they must comply with clause 6.2.3(b).

6.3.4 Data Collection System

(a) *Western Power* must ensure that an appropriate communication system is installed to each *tariff metering installation*.

(b) *Western Power* must establish processes for the collection of *tariff metering data* from each *tariff metering installation* for storage in a *tariff metering data base* in accordance with *Western Power's tariff metering specifications*.

(c) *Western Power* may obtain *tariff metering data* directly from a *tariff metering installation*.

6.3.5 Payment for Metering

(a) The *User* is responsible for payment of all costs associated with the provision, installation, commissioning, maintenance, routine testing and inspection, routine audits, downloading of *tariff metering data*, processing and account resolution for a *tariff metering installation*.

(b) The cost of requisition testing and audits must be borne by the party requesting the test or audit, except where the *tariff metering installation* is shown not to comply with this section, in which case *Western Power* must bear the cost.

6.4 REGISTER OF METERING INFORMATION

6.4.1 Metering Register

(a) As part of the *tariff metering database*, *Western Power* must maintain a *tariff metering register* of all *User tariff metering installations* and *check metering installations* which provide tariff data.

(b) The *tariff metering register* for a particular *User's tariff metering installation* must be made available to the *User* on request.

6.4.2 Meter Register Discrepancy

(a) If a discrepancy is noted between the *User*'s installation and the *tariff metering register, Western Power* must correct the discrepancy within 2 days.

(b) If as a result of the correction of the *tariff metering register* it indicates that the *tariff metering installation* or *check metering installation* does not comply with the requirements of this section, *Western Power* must use its reasonable endeavours to rectify the situation in regard to the *tariff metering installation*. If the *check metering installation* does not comply with the requirement of this section, reference to it will be deleted from the *tariff metering register*.

6.5 TESTING OF METERING INSTALLATION

6.5.1 Responsibility for Testing

(a) Testing of a *tariff metering installation* must be carried out in accordance with *Western Power's tariff metering specifications*.

(b) A *User* may request *Western Power* to arrange for the testing of any *User's tariff metering installation* and *Western Power* must not refuse any reasonable request.

(c) The *User* will have the right to be present at any such testing.

(d) *Western Power* must arrange for sufficient audit testing of *User tariff metering installations* to satisfy itself that each *tariff metering installation* conforms to the requirements of this section.

(e) *Western Power* must have unfettered access to any *User's tariff metering installation* at any time for the purpose of testing the *tariff metering installation*.

6.5.2 Actions in Event of Non-Compliance

(a) If a *tariff metering installation* does not comply with the requirements of this section, *Western Power* must as soon as practical advise the *User* and arrange for the *tariff metering installation* to be made compliant with the requirements of this section.

(b) *Western Power* must in conjunction with the *User* make appropriate corrections to the *tariff metering data* to take account of any errors as a result of the non-compliance found in 6.5.2(a).

6.5.3 Audits of Metering Data

(a) A *User* may request *Western Power* to conduct an audit to determine consistency between the data held in the *tariff metering database* and the *tariff metering data* held in the *User's tariff metering installation*.

(b) If there is an inconsistency between the data held in a *tariff metering installation* and the data held in the *tariff metering database*, the data held in the *tariff metering installation* is to be taken as prima facie evidence of the *tariff metering data*.

6.6 RIGHTS OF ACCESS TO DATA

(a) The only persons entitled to have either direct or remote access to *tariff metering data* from a *tariff metering installation*, the *tariff metering database* or the *tariff metering register* in relation to a *tariff metering point* are:

1) *Western Power*; and
2) The *User* whose account statement relates to energy measured at that *tariff metering point*.

(b) Electronic access to *tariff metering data* from a *tariff metering installation* shall only be provided where appropriate multi level password *tariff meters* are installed and the appropriate software is obtained by the *User*.

6.7 SECURITY OF METERING INSTALLATIONS

6.7.1 Security of Metering Equipment

Western Power is responsible for the security of the *tariff metering installation* and will fit seals or other devices to prevent or disclose unauthorised access.

6.7.2 Security Controls

(a) *Western Power* is responsible for the security of *tariff metering data* held in the *tariff metering installation* and shall prevent local or remote access by suitable passwords and/or other security devices in accordance with clause 6.7.1.

(b) *Western Power* must keep records of electronic passwords secure.

(c) *Western Power* may allocate "read-only" passwords to *User*'s where the *tariff meters* installed have provision for multi-level passwords.

6.7.3 Changes to Metering Equipment, Parameters and Settings

Western Power must record all changes to *tariff metering* equipment, parameters and settings.

6.8 PROCESSING OF METERING DATA FOR SETTLEMENT PURPOSES

6.8.1 Metering Databases

(a) *Western Power* will create, maintain and administer a *tariff metering database* containing information for each *User tariff metering installation*.

(b) The *tariff metering database* must include original energy readings and substitutional calculated values.

6.8.2 Remote Acquisition of Data

(a) *Western Power* is responsible for the remote acquisition of *tariff metering data* and for storing and processing this data for *settlement* purposes.

(b) If remote acquisition becomes unavailable, *Western Power* is responsible for obtaining the relevant *tariff metering data* from the *tariff meters*.

6.8.3 Periodic Energy Metering

Data relating to the amount of *active* and *reactive energy* passing through a *tariff metering installation* is normally collated in trading intervals of between 28 and 35 days inclusive unless it has been agreed between the *User* and *Western Power* that some other period will apply either on an ongoing or once-off basis.

6.8.4 Data Validation

(a) At commissioning, *Western Power* will validate, on-site, the data being recorded by a *tariff metering installation* against the measurement of basic parameters and the *User*'s estimation of *load*.

(b) *Western Power* will compare the data from each of the series *tariff meters* each reading interval as required in clause 6.9.3. Any discrepancy greater than twice the tolerance for the class of *tariff meter* in use will require the *tariff metering installation* to be audited by *Western Power*.

(c) As a result of this audit, all or part of the data from either *tariff meter* may be discarded by *Western Power*. For the purpose of *settlement*, *check metering data*, if available, may be substituted either in whole or part for some or whole of the *tariff metering* readings.

(d) Settlement will normally be based on the average of the readings of the service *tariff meters*.

6.8.5 Errors Found in Metering Tests, Inspections or Audits

(a) If a *tariff metering installation* test, inspection or audit demonstrates that a component of the *tariff metering* has errors in excess of those permitted by its class and it is not possible to determine from other data when the error occurred, the error will be deemed to have occurred at a time halfway between the time the error was found and the time of the previous most recent test or inspection which demonstrated that the installation compiled with Attachment 4 and *Western Power's tariff metering specifications*.

(b) If a test or audit of a *tariff metering installation* demonstrates that a component of a *tariff metering system* has an error less than 1.5 times the error permitted for that component, then no substitution of readings is required.

6.9 CONFIDENTIALITY

Tariff metering data and passwords are confidential data and are to be treated as confidential information.

6.10 METER TIME

(a) All *tariff metering installation* clocks are to be referenced to West Australian Standard *Time* and maintained to a standard of accuracy as required by AS1284.

(b) The *tariff metering database* must be set within an accuracy of 1 second of Western Australian Standard *Time*.

7. DEROGATIONS

7.1 PURPOSE AND APPLICATION

(a) This Section prevails over all other Sections of this *Code*.

(b) *Derogations* of *Users* are:

(1) those provisions of the other Sections of the *Code* 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 *Code* from those provisions currently applying;

(2) providing specific exemptions from the *Code* for pre-existing arrangements *which Western Power* determines must continue beyond a specific transition period; and

(3) providing specific exemptions from the *Code* 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 regulations 26(6), 26(7), 26(8), 26(9), 26(10) and 26(11) of the *Regulations*.

7.2 TRANSMISSION NETWORKS AND FACILITIES EXISTING AT 1 JANUARY 1997

All *plant* and equipment in the *South West Transmission Network* and the *North West Transmission Network,* and all *facilities* connected to these *networks* existing at 1 January 1997 are deemed to comply with the requirements of this Code. 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 at its cost.

ATTACHMENT 1 - GLOSSARY

In this *Code*, 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 Corporation Act 1994 or the Electricity Transmission Regulations 1996 has the meaning given in that Act or those *Regulations* (as the case requires), unless redefined in the table below.

access agreement	Has the meaning given in the *Regulations*.
access application	Has the meaning given in the *Regulations*.
access services	Has the meaning given in the *Regulations*.
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 agreement*.
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 agreement*.
ancillary services	Has the meaning given in the *Regulations*.
ancillary services agreement	An agreement covering the provision of *ancillary services*.
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 *Regulations*.
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 network substation*.
business day	Has the meaning given in the *Regulations*.
capacitor bank	A type of electrical equipment used to generate *reactive power* and therefore support *voltage* levels on *transmission 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.
check meter	A *meter* used as a source of *metering data* for *metering installations* as specified in section 6.
check metering data	The *metering data* obtained from a *check metering installation*.
check metering installation	A *metering installation* which may be used as the source of *metering data* for validation in the *settlements* process.
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.
Code, Technical Code	This *Code* called the *Technical Code* prepared by *Western Power* under regulation 26 of the *Regulations*.
Code commencement date	The date given in clause 1.3 of this *Code*.
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 network*, by direct or indirect connection, so as to have an impact on *power system security, reliability* and *quality of supply.*
connection	Has the meaning given in the *Regulations*.
connection agreement	Has the meaning given in the *Regulations*.
connection asset	Has the meaning given in the *Regulations*.
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 element*.
control centre	The *facility* used by *Western Power* for directing the minute to minute operation of the *power system*.
controller	Has the meaning given in the Regulations.
control system	Means of monitoring and controlling the operation of the *power system* or equipment including *generating units connected* to a *transmission.*
credible contingency event	A *contingency event* the occurrence of which *Western Power* considers to be reasonably possible in the surrounding circumstances.
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 2.5); and 2. Unacceptable disturbance of *power system voltage* or *frequency*.

critical single credible contingency event	A *single credible contingency event* considered by *Western Power*, in the particular circumstances, to have the 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 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 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 *Code* in relation to a *User* according to Section 7.
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 this *Code*.
disconnection, disconnect	The operation of switching equipment or other action so as to prevent the flow of electricity at a *connection point*.
dispatch	The act of committing to service all or part of the generation available from a *scheduled generating unit*.
distribution network	Has the same meaning as ‘distribution system’ in the Electricity Corporation Act 1994.

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 and Electricity Referee Regulations 1997.
electricity transmission capacity	Has the meaning given in the Electricity Corporation Act 1994.
electricity transmission network, network, transmission network	All have the meaning given in the *Regulations* for *electricity transmission network.*
embedded generator	A *generator* which supplies on-site *loads* or *distribution network loads* and is *connected* either directly (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 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 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 clauses 2.2, 2.4 and 5.2.1(a).
frequency response mode	The mode of operation of a *generating unit* which allows automatic changes 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 *Regulations*.
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 into the *generating unit* of the primary *energy* input (for example, steam, gas or water).
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*.
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 network*.
network planning criteria	Has the meaning given in the *Regulations*.
new capacity	Has the meaning given in the Electricity Corporation Act 1994.
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.
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).
North West Transmission Network	The *network* extending from Dampier/Karratha to Roebourne/Cape Lambert and across to Port Hedland, which is depicted and more fully described in *Western Power's* publication 'Description of the Electricity Transmission Networks'.
operational communication	A communication concerning the arrangements for, or actual operation of the *power system* in accordance with the *Code*.
outage	Has the meaning given in the *Regulations*.
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 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 2.4, unless otherwise stated in this *Code* or an *access agreement*.
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 agreement*.
reactive power reserve	Unutilised sources of *reactive power* arranged to be available to cater for the possibility of the unavailability of another source of *reactive power* or increased requirements for *reactive power*.
reactive power support/reactive support	The provision of *reactive power*.
reactor	A device, similar to a *transformer*, specifically arranged to be *connected* into the *transmission 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.
Regulations	Means the Electricity Transmission Regulations 1996.
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	Has the meaning given in the *Regulations*.
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 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.*
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 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 Transmission Network	The *network* extending from Geraldton to Albany and across to the Eastern Goldfields, which is depicted and more fully described in *Western Power's* publication 'Description of the Electricity Transmission Networks'.
spare capacity	Has the meaning given in the Electricity Corporation Act 1994.
standby power	Has the meaning given in the Electricity Corporation Act 1994.
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 network.*
sub-network	A particular portion of the *transmission 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.
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 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*.
tariff meter	A device complying with *Australian Standards* which measures and records the production or consumption of electrical energy that is used for obtaining the primary source of *tariff metering data*.
tariff metering	Recording the production or consumption of electrical *energy*.
tariff metering data	The data obtained from a *tariff metering installation*, the processed data or substituted data.
tariff metering database	A database of *tariff metering data*.
tariff metering installation	The assembly of components between the *tariff metering point(s)* and the point of connection to the public switched telephone network used as the primary source of *tariff metering data* for the *settlements* process. This may include the combination of several *tariff metering points* to derive the *tariff metering data* for a *connection point*.
tariff metering point	The point of physical *connection* of the device measuring the current in the power conductor.
tariff metering register	A register of information associated with a *tariff metering installation* as required by clause 6.4.
tariff metering specifications	Specifications prepared by *Western Power* for equipment including *tariff meter* and communications enclosures, indoor and outdoor *tariff metering* units (*VTs* and *CTs* plus enclosure), *CTs*, *VTs*, marshalling box and wiring.
tariff metering system	The collection of all components and arrangements installed or existing between each *tariff metering point* and the *tariff metering database*.
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.
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.

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.

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 Electricity Corporation Act 1994.
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 in the *Regulations*, but modified in accordance with clause 1.2 of this *Code*.
Western Power power system security responsibilities	The responsibilities described in clause 5.3.1.

ATTACHMENT 2 - RULES OF INTERPRETATION

Subject to the Interpretation Act 1984, this *Code* must be interpreted in accordance with the following rules of interpretation, unless the contrary intention appears:

(a) a reference in this *Code* 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 agreement* 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

SCHEDULES OF TECHNICAL DETAILS TO SUPPORT APPLICATION FOR CONNECTION AND ACCESS AGREEMENT

A3.1. Various sections of the *Code* require that *Users* submit technical data to *Western Power*. This attachment contains schedules which list the typical range of data which may be required. 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 access application*, and will form part of the technical specification in the *access agreement*.

A3.2. Data is coded in categories, according to the stage at which it is available in the build-up of data during the process of forming a *connection* or obtaining access to a *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 agreement* 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 agreement*.

Registered system planning data

This is the class of data which will be included in the *access agreement* signed by both parties. It consists of the preliminary system planning data plus those items denoted in the attached schedules as Detailed Planning Data (D). The latter must be submitted by the *User* in time for inclusion in the *access agreement*.

Registered data

Registered Data consists of data validated and *augmented* prior to actual *connection* a provision of access from manufacturers' data, detailed design calculations, works or site tests etc. (R1); and data derived from on-system testing after *connection* (R2).

All of the data will, from this stage, be categorised and referred to as Registered Data; but for convenience the schedules omit placing a higher ranked code next to items which are expected to already be valid at an earlier stage.

A3.3. Data will be subject to review at reasonable intervals to ensure its continued accuracy and relevance. *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 S6 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*.

Codes:
S = Standard Planning Data
D = Detailed Planning Data
R = Registered Data (R1 pre-*connection*, R2 post-*connection*)

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	% on 100 MVA base	D
	Minimum negative sequence impedance	% on 100 MVA base	D
	Individual Generating Unit Data:		
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	Turbine plus *Generator* Inertia Constant	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
	Generating Unit Resistance:		
RA	Stator Resistance	% on MBASE	S, D, R1, R2
RF	Rotor resistance at 20°C	ohms	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

Symbol	Data Description	Units	Data Category
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
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
	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
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:		
	General description of *excitation control system* (including functional block diagram)	Text, diagram	S, D
	Rated Field *Voltage* at rated MVA and *Power Factor* and rated terminal volts and speed	V	S, D, R1

Symbol	Data Description	Units	Data Category
	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	Text/ Block diagram	D, R2
	Dynamic Characteristics of Under *Excitation* Limiter	Text/ Block diagram	D, R2
	Generating Unit Load Controller (Governor):		
	General description of *governor control system* (including functional block diagram)	Text, diagram	S, D
	Maximum Droop	%	S, D, R1
	Normal Droop	%	D, R1
	Minimum Droop	%	D, R1
	Maximum *Frequency* Dead band	Hz	D, R1
	Normal *Frequency* 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:		

Symbol	Data Description		Units	Data Category
	Symbols	THP TRH TIP TLP1 TLP2	Seconds	D
	Turbine frequency tolerance curve		Diagram	S, D, R1
	Gas Turbine Data: Required data will be advised by *Western Power*.			

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* described in block diagram form showing transfer functions of individual elements, parameters and measurement units. (preferably in IEEE format)	Text, diagram	D, R1, R2
Automatic voltage regulator	Text, diagram	D, R1, R2
Power system stabiliser	Text, diagram	D, R1, R2
Settings of the following controls:		
Details of the *governor system* described in block diagram form showing transfer functions of individual elements and measurement units (preferably in IEEE format).	Text, diagram	D, R1, R2
Over excitation limiter	Text, diagram	D
Under excitation limiter	Text, diagram	D
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

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

Description	Units	Data Category
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
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 g*enerating 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 g*enerating units* as per schedules S1, S2		
Transformers* at *connection points:		
Saturation curve	Diagram	R

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

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

METERING REQUIREMENTS

A4.1 General

(a) *Tariff metering* equipment, other than *tariff meters* and Communications equipment may be provided and installed by the *User* or will be provided and installed by *Western Power* at the *User*'s request.

(b) Indoor *tariff metering* units provided by *Western Power* will normally be of a type suitable for use with a specific make of switchgear which will vary from time to time.

(c) *Tariff meters* and the communications equipment other than a connection to the Public Switched Telephone Network (PSTN) will be provided and installed by *Western Power*. The PSTN connection and any isolation required will be provided by the *User*.

(d) *Tariff metering* equipment will comprise a *tariff metering* unit containing *voltage transformers* (*VTs*) and *current transformers*, or for system *voltages* of 66kV and 132kV, free standing post type *VTs* and *CTs* (other than free standing post type *VTs* and *CTs* may be acceptable and each request will be considered), two or more *tariff meters*, cabling, communications equipment, marshalling box and a *tariff meter* enclosure.

A4.2 Installation

(a) The maximum cable route length between the *CTs* and *VTs* and the *tariff meters* is 80m.

(b) Marshalling boxes located close to the *CTs* and *VTs* will be required for all indoor-*tariff metering* units and for all outdoor-*tariff metering* units for system *voltages* of 66kV and 132kV. Indoor-*tariff metering* marshalling boxes will be an integral part of the indoor-*tariff metering* unit.

(c) Prefabricated free standing or wall mounted *tariff meter* enclosures are available from *Western Power* or a suitable enclosure may be assembled by the *User*. *Tariff meters* may also be located within a building which has provision for unrestricted 24 hour access for *tariff metering* personnel. It may be located adjacent to *Western Power protection* or *SCADA* equipment. Preference is for a purpose constructed, ventilated, insulated or naturally insulated room of plan dimensions not less than 2m X 2m which substantially maintains ambient air temperature. If *Western Power* is requested to provide a free standing *tariff meter* enclosure and its support frame, the *User* will need to provide a concrete footing as specified in *Western Power's tariff metering specifications*.

(d) Unrestricted, 24 hour access to *tariff metering* equipment by *tariff metering* personnel is required.

A4.3 3-4 Wire Metering

Three-wire *tariff metering*, that is, *tariff metering* with three-phase to neutral *VTs* and two *CTs*, one in each of the red and blue currents, may be used when the load measured by the *tariff metering* equipment is a three-wire load. The load is three-wire when it comprises a delta-wound *transformer* primary or a star-wound *transformer* primary with the star point not earthed, provided the *load* is not a distributed *load* and is within 2km of the *tariff metering CTs* and *VTs* and the system *voltage* is less than 66kV. All other *tariff metering* will be four-wire, that is, as for three-wire but with an additional *CT* in the white phase. Co-generation *tariff metering* will normally be four-wire.

Western Power will, if requested by a *User*, advise the *User* whether an installation is 3-wire or 4-wire.

A4.4 Signals

Signals comprising energy usage information may be made available via volt free relay contacts rated to 50V AC or DC at a maximum of 50mA. These signals comprise momentary relay closures each time a given amount of energy (kwh) is imported or exported and each time a given number of kVArh is imported, the start of each 30 minute demand period (or other period if appropriate) and relay closures when the rate changes (on-peak or off-peak or shoulder etc).

A4.5 Accuracy Requirements

TABLE A4.1 Overall Accuracy Requirements of *Tariff Metering Installation*

MAXIMUM LOAD MVA	MINIMUM ACCEPTABLE CLASS OF COMPONENTS	AUSTRALIAN STANDARDS
15.25	0.5 (kVAr class 1.0)	AS1243 AS1675 AS1284
100	0.2 (kVAr class 0.5)	AS1243 AS1675 AS1284

NOTE:

The method for calculating the overall error is the vector sum of the errors of each component part, ie $\underline{a} + \underline{b} + c$, where:

a = the error of the *Voltage Transformer* and wiring

b = the error of the *Current Transformer* and wiring

c = the error of the *tariff meter*.

A4.6 Other Metering Requirements

Specifications for *tariff meter* and communications enclosures, indoor and outdoor *tariff metering* units (*VTs* and *CTs* plus enclosure), 66kV and 132kV *CTs*, *VTs*, marshalling box and wiring are contained in *Western Power's tariff metering specifications*.

ATTACHMENT 10

TEST SCHEDULE FOR SPECIFIC PERFORMANCE VERIFICATION AND MODEL VALIDATION

A5.1 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.

A5.2 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.

A5.3 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).
(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.

A5.4 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.

A5.5 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 A5.2).

A5.5 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 Attachment 3 of this *Code*.

Test Notification

(a) 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.

Test Results

(a) Test result data must be presented to *Western Power* within 5 *business days* of completion of each test or test series.
(b) Where test results are not favourable it will be necessary to rectify problems and repeat tests.

A5.7 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 which corresponds to terminal volts
-

Steam Turbine

- Shaft speed
- Load demand signal
- Valve positions for control and interceptor valves
- Governor 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
- Governor/load reference set point

Hydro

- Shaft speed
- Gate position
- Governor/load reference set point

(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

Test No	TEST DESCRIPTION		
	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
C2	Step change to AVR *voltage* reference with the generator *connected* to the system and at the following outputs (i) 50% rated MW (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 notes below	• nominal stator terminal volts • unity or lagging *power factor* • system base load • generator outputs : (i) 50 % rated MW (ii) 100 % rated MW • all tests in (i) should precede tests (ii) • smaller step changes should precede larger step changes
C3	As for C2 but with the power stabiliser in service and with the system conditions (i) and (ii) as indicated in column 3 (Test Conditions):	As in C2	As in C2, but (i) system base load with no other generation on the same bus (ii) system maximum load and maximum generation on same bus
C4	Manual variation of generator **open circuit** *voltage*	stator terminal voltage (Ut) (a) increase from 0.5 pu to 1.1 pu (b) decrease from 1.1 pu to 0.5 pu	• 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
C5	load rejection (*active power*)	(a) 25 % rated MW (b) 50 % rated MW (c) 100 % rated MW	• nominal stator terminal volts • unity *power factor* • smaller amount should precede larger amount of load rejection
C6	load rejection (*reactive power*)	(a) -30 % rated MVAr	• nominal stator terminal volts

		(b) +25 % rated MVAr	• 0 or minimum MW output
C7	load rejection (*reactive power*)	(a) -30 % rated MVAr	• nominal stator terminal volts • Excitation Manual Control

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