PowerWater

POWER NETWORKS
-
NETWORK CONNECTION TECHNICAL CODE

Revision 2.0
April 2003

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ATTACHMENTS

1 GENERAL

1.1 AUTHORISATION

This *Technical Code* ("*Code*") is the code that is required under section 9 subsection (2) of the Access Code, which states that the *Network Operator* must prepare and make publicly available a network technical code. It is authorised under section 30 subsection (2) of the Access Code, which states that all *Users* must comply with the network technical code. Schedule 1 of the Access Code lists the requirements of this technical code.

This *Technical Code* sets out:

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

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

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

(d) obligations on *Users* to test *plant a*nd 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 the *Network Operator* 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 a*nd equipment;

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

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

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

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

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

(l) *metering* requirements in relation to *connections;*

(m) the information which each *User* is required to provide the *Network Operator* in relation to the operation of *plant a*nd equipment *connected* to the *electricity network* at the *User's connections* and how and when that information is to be provided;

(n) requirements in relation to under *frequency load shedding* with which *Users*

shall comply;

(o) any other matters relating to the *power system* (including the *electricity network)* or *plant a*nd equipment *connected* directly or indirectly to the *electricity network.*

1.2 APPLICATION

In this *Technical Code,* unless otherwise stated, a reference to *Network Operator* or *Power System Controller* refers to the appropriate business unit of the *Power and Water Corporation.*

1.2.1 This *Code* applies to:

(a) The *Power and Water Corporation* in its role as the operator of the *electricity network (Network Operator);*

(b) The *Power and Water Corporation* in its role as the *Power System Controller;*

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

(d) every person to whom access to the *electricity network* is made available (including, without limitation, the *Power and Water Corporation* in its role as a trader of electricity and every person with whom the *Network Operator* has entered into an *access agreement).*

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

(a) in the *Network Operator's electricity networks*; and

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

1.2.3 Other Documents

This *Code* shall be read in conjunction with the following *Power and Water Corporation* documents:

(a) Service Rules;
(b) Installation Rules;
(c) Metering Manual;
(d) Network Policies and Safe Working Procedures; and
(e) System Control Technical Code.

1.3 COMMENCEMENT

This *Code* comes into operation on 1 April 2000 *("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* shall be interpreted in accordance with the rules of interpretation set out in Attachment 2, unless the contrary intention appears.

1.4.1 Conflicts Between Technical Codes

(a) A conflict exists when there is a difference in substance or interpretation of the provisions contained in the Network Connection Technical Code and provisions contained in the System Control Technical Code relating to power system:
(1) reliability;
(2) safety;
(3) security;
(4) operational issues; or
(5) procedures.

(b) In the event of a conflict and to the extent of the inconsistency, the provisions of the System Control Technical Code will prevail over the Network Connection Technical Code.

(c) Where a conflict cannot be resolved under subclause (b), consultations will take place between:
(1) the *Power System Controller*;
(2) the *Network Operator*; and
(3) any affected *User*.

(d) An affected *User* is a *User* who provides evidence to the *Power System Controller* and in the opinion of the *Power System Controller* the evidence proves the *User's* sufficient interest in consultations.

1.5 DISPUTE RESOLUTION

Should a dispute arise between a *User* and the *Network Operator* concerning this code, the *Network Operator* shall negotiate with the *User* to determine mutually acceptable agreed outcomes. If an agreement cannot be reached between these two parties, the dispute shall be arbitrated by the Utilities Commissioner.

1.6 OBLIGATIONS

1.6.1 Obligations of *Users*

All *Users* shall 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 this *Code*; and
(c) *good electricity industry practice* and applicable *Australian Standards*.

1.6.2 Obligations of the Network Operator

(a) The *Network Operator* shall 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) The *Network Operator* shall:

(1) ensure that to the extent that a *connection point* relates to the *electricity 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) The *Network Operator* shall arrange for:

(1) management, maintenance and operation of the *electricity network* 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 *network* 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 practical 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* shall 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 the *Network Operator.*

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

(1) comply with the reasonable requirements of the *Network Operator* in respect of design requirements of equipment proposed to be *connected* in accordance with clause 3.3, including compliance with the *Network Operator's* Service Rules, Metering Manual and Contractors' Bulletins;

(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 the *Network Operator*; and

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

1.6.4 Obligations of *Generators*

(a) A *Generator* shall 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 the *Network Operator.*

(b) Each *Generator* shall:

(1) comply with the reasonable requirements of the *Network Operator* in respect of design requirements of equipment proposed to be *connected* to the *network* of the *Network Operator* 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 the *Network Operator* and *Power System Controller*; 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 the *Network Operator;*

(b) unless otherwise agreed by the *Network Operator;*

(c) unless otherwise agreed; and

(d) except where specifically varied in an *access agreement.*

In all cases any such variation or exemption shall be given in writing to *User(s)* by the *Network Operator.*

1.7.2 Amendments to the Code

The *Network Operator* may amend this *Code*.

2 NETWORK PERFORMANCE CRITERIA

2.1 INTRODUCTION

This Section describes the technical performance requirements of the *network,* and the requirements for co-ordination between *Users* and the *Network Operator* to achieve these.

In particular circumstances, the requirements may be varied, but only with the agreement of the *Network Operator.* However, where it is intended to vary the requirements set down, it shall be demonstrated that the variation will not adversely affect *Users* and *power system security.* Refer to Section 7 - *Derogations.*

Prior to a *User's facilities* being *connected* to the *power system,* the impact on *power system* performance due to the *User's facilities* is to be determined by *power system* simulation studies as specified by the *Network Operator.*

These studies may be performed by the *User* or a third party, in which case, the *Network Operator* 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 the *Network Operator's* discretion. Acceptance of *power system* studies by the *Network Operator* does not absolve *Users* of responsibility/liability for damages or losses incurred by others.

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

2.2 *FREQUENCY* VARIATIONS

The *Network Operator* and *Users* shall 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 *the Network Operator* or *Power System Controller* 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 51.5 Hz for the *network* shall be in accordance with Figure 6 of the standard ANSI/IEEE Std. C37.106-1987. The 60 Hz *frequencies* quoted in the standard should be adjusted to their 50 Hz equivalent *frequencies* by applying a factor of 0.83 to the 60 Hz *frequencies.* Minimum duration of operation at *frequencies* in the range 51.5 Hz to 52 Hz should be 1 minute.

Sustained operation outside the range 47 to 52 Hz need not be taken into account by the *Network Operator* 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 47 Hz but at or above 45 Hz, all *generators* shall remain *connected* to the *Network Operator's network* for a period of at least 2 seconds. Below 45 Hz, instantaneous tripping of *generators* is permitted.

The *Power System Controller* will require the use of *load shedding facilities* (described in clause 2.6 in this section) to aid recovery of *frequency* to the range 49.5 Hz to 50.5 Hz in the *network.* Restoration of *frequency* to within steady state

limits (49.8 Hz to 50.2 Hz for the *network*) shall then be accomplished by operator action.

Frequency stability shall be satisfied under the worst credible *power system load* and *generation* pattern, and the most severe *credible contingencies* of *transmission plant* including the loss of *interconnecting plant* leading to the formation of islands within the *power system.* Even with the formation of islands, each island in the *power system* that contains generation shall have sufficient *load shedding facilities* in accordance with clause 2.6 to aid recovery of *frequency* to the range 49.5 Hz to 50.5 Hz in the *network.*
When islanding occurs the *Power System Controller* will determine which power station or generating units in each isolated system will regulate the frequency in that system.

2.3 POWER-*FREQUENCY VOLTAGE* VARIATIONS

The *Network Operator* shall plan and design *extensions* of its *networks* and equipment for control of *voltage* such that the minimum steady state *voltage* on the *network* will be 90% of nominal *voltage* and the maximum steady state *voltage* will be 110% of nominal *voltage.* However, considerations of economics or voltage stability or the design of existing equipment dictates the limits that apply in different parts of the power system. Other limits may apply following detailed *load-flow* and stability studies.

A requirement for a target range of *voltage* magnitude at a *connection point* shall be specified in *access agreements.* 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 shall be agreed by the relevant *Users.* Short-time variations within 5% of the target values shall be considered in the design of *plant* by *Users.*

Short-circuits in different parts of the *network* cause "dips" in the power-*frequency* phase *voltages* 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 *voltages* may fall to zero or may rise above the nominal *voltage* level).

The *Network Operator and Users* shall ensure that each *facility* that is part of a *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* shall 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 the *Network Operator.*

Users shall 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 the *Network Operator* for excursions in *voltage* fluctuations outside the range specified in this clause 2.4.1 shall be limited to the pursuit of all measures available under 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* shall 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 Table 2.2 for *voltage* levels 66kV and above.

Users shall 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 2.1and 2.2, as applicable.

Responsibility of the *Network Operator* for harmonic *voltage* distortion outside 100% of the limits specified in Tables 2.1, and 2.2 shall be limited to harmonic *voltage* distortion caused by *network* assets and the pursuit of all measures available under 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

Total (odd + even)	**1.5**

Notes to Tables 2.1, 2.2:

1. These tables are derived from AS 2279.2.

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* shall ensure that the level of non-integer harmonic current at each of its *connection points* 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.* 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 2.2 for *voltage* levels 66kV and above.

Users shall 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 and 2.2, as applicable.

Responsibility of the *Network Operator* for harmonic *voltage* distortion outside 100% of the limits (including non-integer harmonics) specified in Tables 2.1 and 2.2 shall be limited to harmonic *voltage* distortion caused by *network* assets and the pursuit of all measures available under 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, shall 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 shall 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 the *Network Operator* for *voltage* notching outside the limits specified in this clause 2.4.2.3 shall be limited to *voltage* notching caused by *network* assets and the pursuit of all measures available under 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 *Network Operator's network.*

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 shall 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 the *Network Operator* for direct current in the neutral outside the limits specified in this clause 2.4.2.5 shall be limited to direct current in the neutral caused by *network* assets and the pursuit of all measures available under 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 2.3.

Users shall ensure that all their *plant* and equipment is designed to withstand without damage or reduction in life expectancy for 100% of the limits as specified in Table 2.3.

Responsibility of the *Network Operator* for *voltage* unbalance outside 100% of the limits specified in Table 2.3 shall be limited to *voltage* unbalance caused by *network* assets and the pursuit of all measures available under 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 2.3
Voltage Unbalance Factor Limits (%)

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

Notes for Table 2.3:

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 of 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 shall be determined accurately for *voltage* levels of 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:

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

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 shall 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 shall cooperate with the *Network Operator* to achieve stable operation of the *networks* and shall install emergency controls as reasonably required by the *Network Operator.* The cost of installation, maintenance and operation of the emergency controls shall 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 shall 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 events* to be considered in accordance with 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* shall be maintained. To ensure transient stability is maintained, due consideration during system studies shall 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;
(3) high speed single phase auto-reclosing and
(4) 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* shall 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* shall be well damped and the *power system* shall return to a stable operating state.

(b) The damping ratio of the oscillations should be at least 0.5. For inter-area 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 shall be taken to change the *power system* configuration and/or *generation dispatch* so as to eliminate such oscillations. Such measures shall be taken by automatic means. *Users* who may cause subsynchronous or supersynchronous resonance oscillations shall provide appropriate measures at the planning and design stage to prevent the introduction of this problem to the *Network Operator's power system* or other *Users'* systems.

2.5.3 Voltage Stability Limits

2.5.3.1 Temporary Over-Voltages:

Temporary AC over-*voltages* shall not exceed the time duration limits given in Australian Standard AS2926 – 1987 unless specific designs are implemented to ensure the adequacy and integrity of equipment on *the Network Operator'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 shall be used to ensure that the transient over-*voltage* seen by an item of *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).

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:

(a) utilisation of available spinning reserve, under the direction of the *Power System Controller*; and
(b) disconnection of system load manually or by means of automatic protection.

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 centres;* 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.* The *Network Operator* will advise *Users* 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* shall be agreed between the *Network Operator* and *Users* and can include the opening of circuits in a *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 the *Network Operator.*

The *Network Operator* shall 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 shall, if reasonably required by the *Network Operator*:

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

(b) co-operate with the *Network Operator* in conducting periodic functional testing of the *facilities,* which shall 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 the *Power System Controller.*

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

2.7 RELIABILITY OF THE NETWORK

The *Network Operator* will design the *reliability* of power supply of its *networks* in accordance with the following criteria:

N, or
N-1.

A section of a *network* designed to the N criterion may result in the loss of all *load* in the area supplied by the *sub-network* for the loss of a *network 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 *sub-network* should allow *supply* to be maintained to that area without loss of *load,* at any load level.

In general the bulk *transmission network* which interconnects the major *power stations* with the *transmission substations* will be designed to the N-1 criterion. The remainder of the *network* may be designed to the N criteria including radial feeds to remote *power system loads* which are normally designed to the N criteria. A risk/benefit analysis and other considerations such as capital investment priorities, social needs, the environment and land use may qualify the *reliability* criteria adopted for each sub-network. In some cases this may mean a more 'lenient' technical solution is permitted, while in other cases stringent performance criteria may be applied.

The reliability criteria in this clause 2.7 apply only to the *electricity networks and* not to *connection* assets. *Connection* assets will be designed in accordance with a *User's* requirements.

The contingency criteria to which the *network* has been designed shall 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 NETWORK

For the *network* designed to operate with the N-1 criterion the *network* shall 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.

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 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 2.4.

Table 2.4
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)	*Network 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 *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: Ratings appropriate for the season based on:

a) ambient temperature being that for 1% probability of daily maximum temperature not being exceeded;
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 Australian Standard HB C(b)1.

2.9.3 Fault limits:

The calculated fault levels in the *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 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.

The ESAA National Electricity Network Safety (NENS) Code shall be applied and reference shall be made to the NENS Reference Guidelines.

2.11 ENVIRONMENTAL CRITERIA

Environmental management of the transmission and distribution networks will be in keeping with the ESAA Code of Environmental practice. This applies in planning, construction, operation and decommissioning.

Users shall inform and consult with relevant public bodies, community interest groups and the general public, and shall avoid where economically possible the use of land where conflicting uses or potential conflicting uses exist.

2.12 CONSTRUCTION CRITERIA

2.12.1 Overhead Lines

Overhead lines and cable systems shall be designed and constructed to Australian Standard HB C(b)1, “Guidelines for Design and Maintenance of Overhead Distribution and Transmission Lines”.

2.12.2 Underground Cables

Cables shall be installed in a manner that takes into account the local environmental and service conditions, the location of other utilities’ services and the risk of damage from excavation. Installation practices shall be in accordance with ESAA Code C(b)2, “Guide to the Installation of Cables Underground”.

3 TECHNICAL REQUIREMENTS OF *USERS' FACILITIES*

3.1 INTRODUCTION

This Section sets out details of the technical requirements which *Users* shall 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.*

This Section applies only to *Users* with *generation* or load, or both, likely to have a major impact on the *Network*. For *Users*, particularly load *Users*, with a relatively minor impact on the *Network*, only compliance with the *Network Operator's* Service Rules, Metering Manual, Contractors' Bulletins and any conditions included in a *Connection Agreement* are required.

3.2 CONDITIONS FOR CONNECTION OF GENERATORS

The *Network Operator* 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 the *Network Operator* a *User* shall provide *power system* stabilising facilities on each *synchronous generating unit* if *power system* simulations indicate such a requirement.

(b) If required by the *Network Operator*, a *User* shall 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.

(c) A *User* shall ensure that its *generating unit(s)* comply with the requirements advised by the *Network Operator* as to the minimum subtransient reactance that the *generating unit* may have if necessary to control fault levels on the *network.*

(d) A *User* shall ensure that its *generating unit(s)* satisfy the *Network Operator's* reasonable requirements to ensure stability of the *electricity 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 the *Network Operator* shall use all reasonable endeavours to agree upon the following matters in respect of each new or altered *connection:*

(a) Design at *connection point;*

(b) Physical layout adjacent to *connection point;*

(c) *Protection* and backup;

(d) Control characteristics;

(e) Communications, *metered* quantities and alarms;

(f) Insulation co-ordination and lightning protection;

(g) Fault levels and fault clearing times;

(h) Switching and *isolation facilities;*

(i) Interlocking arrangements;

(j) *Metering installations* as described in Section 6;

(k) *synchronising facilities;*

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

(m) Out of step/pole slip facility

(n) any special test requirements.

Prior to *connection* to the *Network Operator's power system,* the *User* shall have provided to the *Network Operator* a signed 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.*

3.2.3 Provision of Information

The *User* shall provide all data reasonably required by the *Network Operator.* This data shall include full models (and all model parameters) of the *generating units*, *excitation control systems*, turbine / engine *governor systems*, and *power system stabilisers* to enable the *Network Operator* to conduct dynamic simulations. These models shall be in a form which is compatible with the *power system* analysis software used by the *Network Operator* (currently PSS/E from Power Technologies, Inc.) and shall be inherently stable. 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 the *Network Operator:*

(1) Each *synchronous generating unit* shall 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* shall be capable of absorbing *reactive power* at a leading *power factor* less than or equal to 0.9.

(2) Each *asynchronous generating unit* shall 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* shall reach a commercial arrangement under the *access agreement* with the *Network Operator* for the *supply* of the deficit in *reactive power* as measured at the *generating unit's* terminals.

(c) The *Generator connection* shall 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* shall *generate* a constant *voltage* level with balanced phase *voltages* and harmonic *voltage* distortion equal to or less than permitted in accordance with either *Australian Standard AS* 1359 "General Requirements for Rotating Electrical Machines" or a recognised relevant international standard, as agreed between the *Network Operator* and the *User.*

For *non-synchronous generators* the contributions to *quality of supply* shall 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, shall 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, shall 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 *network* fault which causes *voltage* at the *connection point* to drop to zero for up to one 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 *Load* Rejection

A generating unit shall be capable of continuous uninterrupted operation, during and following a *load* reduction which occurs in less than 0.5 seconds, from a fully or partially *loaded* condition provided that the *load* reduction is less than 50% of the *generating unit's nameplate rating* and the *load* remains above minimum load or as otherwise agreed between the *Network Operator* and the relevant *User* and stated in the *access agreement* between them.

3.2.4.5 *Loading* Rates

A *scheduled generating unit* shall 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 the *Network Operator* and the relevant *User,* stated in their *access agreement.*

3.2.4.6 Safe Shutdown without External Electricity *Supply*

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

3.2.4.7 Restart Following Restoration of External Electricity *Supply*

If reasonably required by the *Network Operator*, a *generating unit* shall 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* shall 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. If reasonably required by the Network Operator, 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 *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 *Network Operator's network* for a period of at least two 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) of this clause shall be consistent with *power system* performance requirements specified in Section 2 and shall be approved by the *Network Operator* in respect of their potential to reduce *power system security.* They shall 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.

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

3.2.4.9 *User Protection Systems* That Impact On *Power System Security*

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

3.2.4.10 Generator *Transformer* Tapping

Unless otherwise agreed between the *Network Operator* and the *User,* the generator *transformer* of a *generating unit* shall be capable of off-*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 the *Network Operator*, the tripping of a *User's generating unit* which is *connected* to the *network* will require the intertripping of *associated loads* within 0.2 seconds unless the *loads* are the subject of a *connection agreement* with the *Network Operator* and 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

The *Network Operator* will require the *User* to:

I. provide *remote monitoring equipment ("RME")* to enable the *Network Operator* and the *Power System Controller* 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 the *Network Operator,* 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) shall
conform to an acceptable standard as agreed by the *Network Operator* and shall be compatible with the *Network Operator'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 *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 the *Network Operator.*

3.2.5.2 Remote Control

A *User* may install *remote control equipment* ("*RME*") that is adequate to enable the *Power System Controller* to remotely control:

(1) the *active power* output of any *generating unit*; and
(2) the *reactive power* output of any *generating unit*;

in a system emergency.

Where a *User* does not provide RCE, the *User* must satisfy the *Network Operator* and the *Power System Controller* that adequate arrangements are in place to allow the *Power System Controller* to give directions to the *User* for the control of the *User's generating units* in a system emergency, and to allow the *User* to respond appropriately to those directions. These arrangements shall include the control of *active power* and *reactive power*.

Note: Unless agreed otherwise, the relevant *User* will be responsible for the following actions at the request of the *Network Operator* :

(1) activating and de-activating *RCE* installed in relation to any *generating unit*; and

(2) setting the minimum and maximum levels to which, and a maximum rate at which, the *Power System Controller* will be able to adjust the performance of any *generating unit* using *RCE*.

3.2.5.3 Communications Equipment

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

A User shall provide communications paths (with appropriate redundancy) between the *RME* or *RCE* installed at any of its *generating units* to a communications interface at the *relevant power station* and in a location reasonably acceptable to the *Network Operator.* Communications systems between this communications interface and the relevant *control centre* shall be the responsibility of the *Network Operator* unless otherwise agreed. The *User* shall meet the cost of the communications systems*,* unless otherwise determined by the *Network Operator .*

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

(a) Primary Speech Facility

Each *User* shall 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 the *Power System Controller.*

The *facilities* to be provided, including the interface requirement between the *Power System Controller's* equipment and the *User's* equipment shall be specified by the *Network Operator.*

(b) Back-up Speech Facility

Where the *Network Operator* advises a *User* that a back-up *speech facility* to the *primary facility* is required, the *Network Operator* will provide and maintain a separate telephone link or radio installation. The costs of the equipment shall be recovered through the charge for *connection.*

The *Network Operator* shall be responsible for radio system planning and for obtaining radio licenses for equipment used in relation to the *Network Operator networks.*

3.2.5.4 Governor System

All *generating units* shall have an automatic governing system capable of droop governing. These governor systems shall include *facilities* for both speed and *load* control. The droop setting of the governor shall be adjustable and capable of operating in the range 1% to 6% droop. The *Power System Controller* will determine the governor mode of a *generating unit* in the system.

Unless otherwise agreed between the *Network Operator* and the relevant *User* and stated in the *access agreement* between them, *generating units* shall normally be operated in 'droop' mode.

If in the *access agreement*, the *Network Operator* and the relevant *User* agree to operate the *generating unit* in 'block load' mode (constant *active power* output of the *generating unit*) or 'import/export' mode (constant *active power* delivery into the system at the *connection point*), the *generating unit* shall automatically change to regulating mode if the *generating unit* is islanded from the system.

The *User* shall notify the *Power System Controller* prior to a *generating unit* being operated in a mode where the *generating unit* will be unable to respond as specified in the *access agreement.*

The steady state deadband 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) shall be less than 0.05Hz.

For a *load* increase of 20% of the *generating unit's nameplate rating,* the *generating unit* shall re-enter the steady state deadband within 1 second of the *load* change, provided that the *load* on the *generating unit* after the *load* increase does not exceed the *generating unit's nameplate rating*.

The *governor system* of a *generating unit* shall be adjusted for stable performance under all operating conditions.

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) shall be provided to the *Network Operator* in sufficient detail to enable the dynamics of these components to be characterised for short and long term simulation studies. This shall include a control block diagram and all model parameters in suitable form to perform dynamic simulations and compatible with the *power system* analysis software used by the *Network Operator* (currently PSS/E from Power Technologies, Inc.). The proposed settings for the *governor system* for all expected modes of governor operation shall also be provided. These parameters shall not be varied without prior approval of the *Network Operator .*

3.2.5.5 Excitation Control System

The *excitation control system* of a synchronous *generating unit* shall 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 shall 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 the *Network Operator .*

New synchronous *generating units* shall be fitted with fast acting *excitation control systems* utilising modern technology. A.C. exciter, rotating rectifier or *static excitation systems* shall be provided for any new *generating units* with a rating greater than 10 MW or for new smaller *generating units* within a *power station* totalling in excess of 10 MW. *Excitation control systems* shall provide *voltage* regulation to within 0.5% of the selected setpoint value.

If required by the Network Operator, synchronous *generating units* shall 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 the *Network Operator .* The stabilising circuits shall be responsive and adjustable over a *frequency* range which shall include frequencies from 0.1 Hz to 2.5 Hz.

Before commissioning of any *power system stabiliser*, its preliminary settings should be agreed by the *Network Operator .* The *User* should propose these preliminary settings which should be derived from system simulation studies and the study results reviewed by the *Network Operator .*

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

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 ±1% of its increment value.

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 form rated *voltage* to *excitation* ceiling *voltage* following the application of a short duration impulse to the *voltage* reference.	s	0.05 maximum	0.5 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*. Shall 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

The *Network Operator* shall approve 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.

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

Settings may require alteration from time to time as advised by the *Network Operator.* The cost of altering the settings and verifying subsequent performance shall 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 shall pay all costs on that occasion.

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

protection systems.

3.2.6 Power Station Auxiliary *Transformers*

In cases where a *power station* takes its auxiliary supplies through a *transformer* via a separate *connection point,* the *User* shall comply with the conditions for *connection* of *loads* (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 *connecting* the *User's generating plant* to the *network.*

Prior to the initial *synchronisation* of the generating unit(s) to the *network,* the *User* and the *Power System Controller* 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, shall be provided by a *User.*

3.2.9 Design Requirements for *Users' Substations*

Users shall comply with the requirements of clause 3.3.6.

3.3 CONDITIONS FOR *CONNECTION* OF *LOADS*

The following applies to the *connection* of *loads* to *networks.* It represents typical requirements and particular provisions may be waived for smaller *Users* and *Users* that have no potential to affect other *Users,* at the discretion of the *Network Operator.* Nothing in this section waives the requirements for all installations to comply with the *Network Operator's* Service and Installation Rules, Metering Manual, Contractor's Bulletins, and any requirement included in a *Connection Agreement*.

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 the *Network Operator :*

(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 Electricity Supply Association of Australia Substation Earthing Guide, or Australian Standard AS3000, or both, as appropriate.

(g) *Plant* and earth grid test certificates from approved test authorities.

(h) A primary/secondary injection test of *protection* and trip test certificates on all circuit breakers.

(i) Certification that all new equipment has been inspected before being *connected* to the *supply.*

(j) Operational procedures.

(k) Calculated maximum demand of the installation.

(l) Details of potentially disturbing *loads.*

(m) *SCADA* arrangements.

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

3.3.2 Design Standards

A *User's* installation shall 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 *Network Operator 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 the *User's* cost, and within a time frame reasonably required by the *Network Operator*.

3.3.3 *User Protection Systems* That Impact On *Power System Security*

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

3.3.4 *Connection Point* For A *User*

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

3.3.5 *Power Factor* Requirements

Power factor ranges to be met by *Users* for their *loads* 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 the *Network Operator*)
132kV / 66kV <66kV	0.95 lagging to unity 0.9 lagging to 0.9 leading

The *Network Operator* 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 transfers.*

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

A *User* who installs *static VAr compensator* systems for either *power factor* or *quality of supply* requirements shall ensure its control system does not interfere with other normal control functions on the *electricity network.* Adequate *filtering facilities* shall be provided if reasonably required by the *Network Operator* to absorb any excessive harmonic currents.

3.3.6 Design Requirements for *Users' Substations*

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

(a) Safety provisions shall comply with requirements applicable and notified by the *Network Operator ;*

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

(c) A *substation* shall 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* shall be in accordance with the Electricity Supply Association of Australia Substation Earthing Guide, and shall reduce step and touch potentials to safe levels.

(e) *Synchronisation facilities* or reclose blocking shall 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, shall be provided.

(g) *Plant* shall be tested to ensure that the *substation* complies with the design and specifications required by clause 3.3.6(j). Where appropriate, type test certificates provided by the manufacturer satisfy this section.

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

(i) Insulation levels of *plant* in the *substation* shall 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 *Network Operator's power system*, the *User* shall have provided to the *Network Operator* 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*

If reasonably required by the *Network* Operator, *Users* are to provide automatic interruptible *load* to the *Network Operator* in accordance with clause 2.6.

3.3.8 Monitoring and Control Requirements

3.3.8.1 Remote Monitoring

The *Network Operator* may require the *User* to:

I. provide *remote monitoring equipment ("RME")* to enable the *Network Operator* 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 the *Network Operator,* 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) shall conform to an acceptable standard as agreed by the *Network Operator* and shall be compatible with the *Network Operator'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 *network*

(b) Alarms

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

(c) Measured Values

(1) *active power load*
(2) *reactive power load*
(3) *load* current
(4) relevant *voltages* throughout the *plant*

(d) Sequence-of-event (SOE) points

(1) *protection* operation
(2) circuit breaker status

(e) Such other input information reasonably required by the *Network Operator .*

3.3.8.2 Communications Equipment

A *User* shall provide electricity supplies for any *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* shall provide communications paths (with appropriate redundancy) between any *RME* installed at its *plant* to a communications interface at the relevant *plant* and in a location reasonably acceptable to the *Network Operator.* Communications systems between this communications interface and the relevant *control centre* shall be the responsibility of the *Network Operator* unless otherwise agreed. The cost of the communications systems shall be met by the *User,* unless otherwise determined by the *Network Operator .*

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, shall 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 to the requirements of this clause 3.4 will vary from installation to installation. Consequently, each installation will need to be assessed individually by the *Network Operator . Users* will be advised accordingly.

It is important to note that the requirements of this clause 3.4 are designed to

adequately protect the *Network Operator'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 the *Network Operator* 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 times,* 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 times* 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 the *Network Operator* in the interests of system integrity and other *Users.* 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 shall at least comply with IEC Standard 255.

3.4.2.2 Availability of *Protection*

A *User* shall ensure, when reasonably required by the *Network Operator,* that all equipment is protected by two independent *protection schemes* and that all elements of both protection schemes, including associated intertripping, are well maintained so as to be available at all times. Short periods of unavailability of one *protection scheme* (up to 24 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* shall notify the *Network Operator* at least 5 *business days* prior to taking one of the two *protection schemes* out of service.

Where appropriate, and with the approval of the Network Operator, a single set of HRC fuses may be used as a *protection scheme* for plant at 33 kV and below, in which case a second *protection scheme* would not be required to satisfy the requirements of this Section.

3.4.2.3 Duplication of *Protection*

Except as provided in Section 3.4.2.2, two fully *independent protection schemes, connected* to operate in a "one out of two" arrangement, will comprise a complete scheme. To maintain the integrity of the two *protection schemes,* no cross *connections* are to be made between them. Also it shall 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 schemes* require end to end communications, independent *teleprotection signalling* equipment and communication channels shall be provided. Further, independent communication bearers are needed for each signalling channel where failure of the signalling will result in neither *protection scheme* meeting its basic *sensitivity* and operating time criteria.

The two fully independent *protection schemes* may not be dedicated to the one item *of primary plant.* One of the *protection schemes* may in fact be a *remote backup protection.* Both *protection schemes* shall, however, meet the *critical fault clearance times* and clearance time requirements of section 3.4.2.5, be located on *User* equipment and discriminate with the *Network Operator's 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* at 66 kV and above*,* 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.

For plant at 33kV and below where the *critical fault clearance time exists*, only one *protection scheme* is required to meet the smaller of the critical fault clearance time and the total fault clearance time for plant at 33KV and below as given in clause 3.4.2.5. The *other protection scheme* is required to meet the second protection time as given in clause 3.4.2.5

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

3.4.2.5 Maximum Acceptable *Total Fault Clearance Time*

For all *plant* at 66kV and above, *both protection schemes are* required to meet the clearance times given in Table 3.3 below.

Table 3.3
132 kV and 66 kV Total *fault clearance times* (msec)

		No CB Fail	CB Fail
132kV and 66kV	Local	150	400

	Remote	200	450

For plant at 33kV and below where the *critical fault clearance time exists*, only one *protection scheme* is required to meet the smaller of the critical fault clearance time and the total fault clearance time shown in Table 3.4. The *other protection scheme* is required to meet the second protection time as given in Table 3.5

For plant at 33KV and below where there is no critical fault clearance time, one protection scheme may be used which is required to meet the fault clearance times shown in Table 3.5 below. A second protection would not be required.

Table 3.4
33KV and Below Total *fault clearance times* (msec)

		No CB Fail	CB Fail
33KV and below	Local	150	500
	Remote	200	600

Table 3.5
Second *Protection fault clearance times* (msec) for Plant at or Below 33kV

		No CB Fail	CB Fail
33kV and below	Local	500	1000

In the Tables 3.3, 3.4, and 3.5, "Local" refers to a fault within the first 80% of the line and "Remote" refers to the last 20% of the line.

3.4.2.6 *Sensitivity* of *Protection*

All *protection schemes* shall 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 shall 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.

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

In rural areas where the earth return impedance is high, sensitive earth fault *protection* may also be required, in addition to the above *backup* and primary *protection*.

3.4.2.7 Clearance of *Small Zone Faults*

Small zone faults shall be detected and cleared by *backup protection* as specified in clause 3.4.2.5.

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, when reasonably required by the *Network Operator,* be detected and the primary fault current shall be cleared by *backup protection* as specified in the

clause 3.4.2.7.

3.4.2.9 *Protection* of *Interconnections* and Ties

The *User* shall provide *protection* to detect and clear faults on the *interconnection* or tie between their system and the *Network Operator 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 shall be detected and cleared by at least one *protection scheme* somewhere in the system, *protection schemes* 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 50% of nominal DC *supply voltage.*

3.4.2.11 *Protection* Flagging and Indication

All protective devices supplied to satisfy the *User/ Network Operator 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 the *Network Operator , Users* shall provide the *Network Operator* 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.* The *Network Operator* shall provide comments on a *User's* proposed *protection* designs within 65 *business days*, unless otherwise agreed.

3.4.2.15 Details of Proposed *User Protection* Settings

Unless agreed otherwise, *Users* shall provide the *Network Operator* with full details of proposed *protection* settings and setting calculations on all *plant* that may impact on the *Network Operator's power system* a minimum of 65 *business days* 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 *Network Operator protection* settings. Where this is not possible, the *User* will be responsible for the cost of revising *Network Operator* settings and upgrading *Network Operator* or other *Users'* equipment, where required.

Generally, *Network Operator protection* which discriminates on the basis of time employs devices with standard inverse characteristics to BS 142 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 400 msec and Zone 3 time to 1000 msec.

Specific details of *Network Operator protection* are available on request.

3.4.2.17 Commissioning of *Protection*

The *Network Operator* 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 *Network Operator power system.* The *User* shall pay *Network Operator'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*

Users shall regularly maintain their *protection systems* at intervals of not more than 3 years. Records shall be kept of such maintenance and these may be reviewed by the *Network Operator .* 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

Protection shall be by *two fully independent protection schemes of differing principle,* each one discriminating with the *Network Operator power system* and capable of meeting the *critical fault clearance time.*

One of the *protection schemes* shall include earth *fault protection* to give additional coverage for low level earth faults and to provide some *remote backup.*

3.4.3.2 Interconnectors and Ties operated at 33kV and Below

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

3.4.3.3 Feeders, Reactors, Capacitors and other *Plant* operated at 33kV and Below

Where a *critical fault clearance time* exists, *protection* of these items will be by two *independent protection schemes of differing principle,* each one discriminating with the *Network Operator power system* and capable of meeting the *critical fault clearance time.* At least one of these *protection schemes* 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
- Instantaneous Earth Fault

or

- A single set of HRC fuses, where appropriate, and with the approval of the *Network Operator.*

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 *Network Operator power system.* Where the *Network Operator protection* is overcurrent, the maximum operate time will be 1 second at maximum fault level. Generally, *Network Operator* 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.

3.4.3.4 *Transformers*

For 66kV and above, *protection* will be by *two fully independent protection schemes of differing principle,* each one discriminating with the *Network Operator system and* capable of meeting the *critical fault clearance time.*

For 33kV and below*, protection* will be by two *protection schemes* which are *complementary* and discriminate with the *Network Operator power system.* These *protection schemes* are to meet the *fault clearance times* specified in clause 3.4.2.5.

The composition of each of the two *protection schemes* 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 shall still be achieved by *transformer protection,* but may be delayed until the nature of the fault changes or evolves.

Protection of *transformers* larger than 3 MVA will require at least one of the protection schemes to be a *unit protection* and provide high speed fault clearance of *transformer* faults.

3.4.3.5 *Generators*

Protection of generators shall generally be at the discretion of the *User,* but shall be sufficient to protect the generator from faults on the *Network Operator power system. Protection* will be by *two fully independent protection schemes of differing principle,* each one discriminating with the *Network Operator power system.* Where a *critical fault clearance time* exists, each *protection* shall be capable of meeting the *critical fault clearance time.* These *protection schemes* are to meet the *fault clearance times* 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 *Network Operator power system* in the event of any of the above *protection schemes* operating.

- Separation of the *User's generation* from the *Network Operator power system* in the event of loss of *supply* to the *User's* installation from the *Network Operator's power system.*

- Prevention of the *User's generation* from *energising de-energised Network Operator plant,* or *energising* and *supplying* an otherwise isolated portion of the *Network Operator's power system.*

- Adequate *protection* of the *Users* equipment and complete installation without reliance on back up from the *Network Operator's protection.*

3.4.3.6 *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 *Network Operator's power system* where the risk of out of *synchronism* closure is unacceptable. This will be installed by the *Network Operator* 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.

3.4.3.7 *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 *Network Operator's 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 shall be alarmed within the *Users* installation and operating procedures put in place to ensure that prompt action is taken to remedy such failures.

3.4.3.8 *Backup Protection*

Backup protection shall be provided to detect and clear faults involving *small zones. 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 times* 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 the *Network Operator* in the *access agreement.*

Such *protection schemes* shall be capable of detecting and initiating clearance of uncleared or *small zone faults* under both normal and *minimum system conditions.* Under abnormal *plant* conditions, all primary system faults shall 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.

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

Unless otherwise agreed by the *Network Operator , a User* shall ensure that islanding of its *generation plant* together with part of the *Network Operator power system,* cannot occur upon loss of *supply* from the *Network Operator's 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 *Network Operator's power system.* Islanding shall only occur in situations where the *power system* is unlikely to recover from a major disturbance.

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

Users shall co-operate to agree with the *Network Operator* 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,* the *Network Operator* and/or another *User(s)* to account for the higher level of *access service.*

3.4.3.10 *Automatic Reclose Equipment*

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 *Network Operator .*

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

4.1 INSPECTION AND TESTING

4.1.1 Right Of Entry and Inspection

(a) The *Network Operator* 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 this *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 the *Network Operator* wishes to inspect the *facilities* of a *User* under clause 4.1.1(a), the *Network Operator* shall 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 the *Network Operator* reasonably considers requires access to the *User's facility,* prior notice is not required, however, the *Network Operator* shall notify the *User* as soon as practical after deciding to enter the *User's facility* of the nature and extent of the *Network Operator's* activities at the *User's facility.*

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

(1) the name of the *representative* who will be conducting the inspection on behalf of the *Network Operator ;*

(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) The *Network Operator* 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 the *Network Operator* is in a *User's facility,* that *representative* shall:

(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 the *Network Operator* conducting an inspection under this clause 4.1.1 shall be appropriately qualified and experienced to perform the relevant inspection. If so requested by the *User*, the *Network Operator* shall procure that a *representative* of *Network Operator* (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 shall be borne by the *User* if the suspected non-compliance is later proved by tests.

(h) Any inspection under clause 4.1.1 (a) shall not take longer than one day unless the *Network Operator* 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) shall 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) shall 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) shall not create or cause to be created any mortgage, charge or lien over any such equipment or goods; and

(4) shall 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 the *Network Operator* has reasonable grounds to believe that equipment owned or operated by a *User* may not comply with this *Code* or the *access agreement*, the *Network Operator* 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 the *Network Operator .*

(c) The *User* who receives a notice under clause 4.1.2(a) shall 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) shall be borne by the *Network Operator ,* unless the equipment is determined by the tests not to comply with the relevant *access agreement*, and/or this *Code* in which case all reasonable costs of such tests shall be borne by the owner of that equipment.

(e) Tests conducted in respect of a *connection point* under clause 4.1.2 shall 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 shall be conducted only by persons with the relevant skills and experience.

(g) If the *Network Operator* requests a test under this clause 4.1.2, the *Network Operator* may appoint a *representative* to witness a test and the relevant *User* shall 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 shall submit a report to the *Network Operator* 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 this *Code* or the relevant *access agreement* then the *User* shall:

(1) promptly notify the *Network Operator* of that fact; and

(2) promptly advise the *Network Operator* 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 the *Network Operator* 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) The *Network Operator* 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), the *Network Operator* shall 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* shall provide evidence to the *Network Operator* that each of its *generating units* complies with the technical requirements of Clause 3.2 and the relevant *access agreement.* In addition, each *User* shall 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 the *Network Operator* , and *Users* will be advised accordingly.

(b) Each *User* shall negotiate in good faith with the *Network Operator* 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* shall:

(1) promptly notify the *Network Operator* of that fact; and

(2) promptly advise the *Network Operator* 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 the *Network Operator* on progress in implementing the remedial action; and

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

(d) If the *Network Operator* reasonably believes that a *generating unit* is not complying with one or more technical requirements of Clause 3.2 and the relevant *access agreement,* the *Network Operator* 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) *Network Operator* shall reimburse *the User* for the reasonable expenses incurred as a direct result of conducting the tests.

(e) If the *Network Operator :*

(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 *power system security,*

the *Network Operator* 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 the *Network Operator* that the *generating unit* is complying with the relevant technical requirement.

(f) A *direction* under clause 4.1.3(e) shall be recorded by the *Network Operator*

(g) From the *Code commencement date* or from the date of access, whichever is the later, each *User* shall 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 *Network Operator* on request.

4.1.4 Routine Testing of *Protection* Equipment

(a) Subject to clause 3.4.2.18, a *User* shall cooperate with the *Network Operator* 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* shall 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 the *Network Operator* and the *User.*

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

(c) Each *User* shall pay the *Network Operator's* reasonable costs and shall bear its own costs of conducting tests under this clause 4.1.4.

4.1.5 Testing By *Users* 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,* shall give notice in writing to the *Network Operator* 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) The *Network Operator* shall 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 the *Network Operator's* reasonable opinion, a test could threaten public safety, damage or threaten to damage equipment or adversely affect the operation of the *power system,* the *Network Operator* may direct that the proposed test procedure be modified or that the test not be conducted at the time proposed.

(e) The *Network Operator* shall advise any other *Users* who will be adversely affected by a proposed test and consider any reasonable requirements of those *Users* when approving the proposed test.

(f) The *User* who conducts a test under this clause 4.1.5 shall ensure that the person responsible for the coordination of a test promptly advises *Network Operator* when the test is complete.

(g) If the *Network Operator* approves a proposed test, the *Network Operator* shall use its reasonable endeavours to ensure that *power system* conditions reasonably required for that test are provided as close as is reasonably practical 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 shall provide the *Network Operator* with a report in relation to that test including test results where appropriate.

4.1.6 Tests Of *Generating Units* Requiring Changes to Agreed Operation

(a) The *Network Operator* 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 the *Network Operator* in order to determine analytic parameters for modelling purposes or to assess the performance of the relevant *generating unit*. The *Network Operator* is entitled to witness such tests and the *Network Operator* shall have reasonable grounds for requiring such tests.

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

(c) The *Network Operator* shall 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* shall 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* shall provide any reasonable assistance requested by the *Network Operator* in relation to the conduct of tests.

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

(g) The *Network Operator* shall 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* shall 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 *networks* or investigating *power system* performance shall be coordinated and approved by the *Network Operator* . The *Network Operator* or a *User* requesting such tests shall 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 *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) The *Network Operator* shall notify all *Users* who could reasonably be expected to be affected by the proposed test at least 15 *business days* before any test under this clause 4.1.7 may proceed and to consider any reasonable requirements of those *Users* when approving the proposed test.

(d) Operational conditions for each test shall be arranged by the *Network Operator* and the test procedures shall be coordinated by an officer nominated by the *Network Operator* 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* shall cooperate with the *Network Operator* when required in

planning, preparing for and conducting *network tests* to assess the technical performance of the *networks* and if necessary conduct co-ordinated activities to prepare for *power system* wide testing or individual, on-site tests of the *User's facilities* or *plant,* including *disconnection* of a *generating unit.*

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

(g) The *Network Operator* shall 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 the *Network Operator* 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 the *Network Operator.* 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* shall 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* and any relevant *access agreement* prior to or within an agreed time after being *connected* to a *network*, and the *Network Operator* is entitled to witness such inspections and tests.

(b) The *User* shall produce test certificates on request by the *Network Operator* 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* shall cooperate with the *Network Operator* to develop procedures to ensure that the commissioning of the *connection* and *connected* facility is carried out in a manner that:

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

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

4.2.3 Control and *protection* settings for equipment

(a) Not less than 65 *business days* 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* shall submit

to the *Network Operator* sufficient design information including proposed parameter settings to allow critical assessment including analytical modelling of the effect of the new or replacement equipment on the performance of the *power system.*

(b) The *Network Operator* shall:

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

(d) The *Network Operator* and the *User* shall negotiate parameter settings that are acceptable to them both.

(e) The *User* and the *Network Operator* shall 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* shall pay the *Network Operator'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 days* 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* shall advise *the Network Operator* in writing of the commissioning program including test procedures and proposed test equipment to be used in the commissioning.

(b) The *Network Operator* shall, within 20 *business days* of receipt of such advice under clause 4.2.4(a), notify the *User* either that it:

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

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

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

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

(e) The *User* shall pay the *Network Operator's* reasonable costs associated with the assessment of the commissioning program under this clause 4.2.4.

4.2.5 Commissioning Tests

(a) The *Network Operator* 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 *Network Operator's power system,* the *User* shall have provided to the *Network Operator* a signed written statement to certify that the equipment to be *connected* has been installed in accordance with 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) The *Network Operator* shall, 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 shall submit to the *Network Operator* 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 the *Network Operator .*

(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 shall promptly meet with the *Network Operator* to agree on a process aimed at achievement of compliance of the relevant item with this *Code.*

(e) The *Network Operator* 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* shall pay the *Network Operator's* reasonable costs associated with the witnessing of commissioning tests under this clause 4.2.5.

4.3 *DISCONNECTION* AND RECONNECTION

4.3.1 Voluntary *Disconnection*

(a) Unless agreed otherwise and specified in an *access agreement,* a *User* shall give to the *Network Operator* 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* shall be implemented in accordance with clause 4.3.2.

(c) The *User* shall 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, the *Network Operator* and the *User* shall, prior to such *disconnection* occurring, follow agreed procedures for *disconnection.*

(b) The *Network Operator* shall notify other *Users* if it believes, in its reasonable opinion, the terms and conditions of such an *access agreement* will be affected by procedures for *disconnection* or proposed procedures agreed with any other *User* The parties shall 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) shall be followed by the *Network Operator* and all *Users.*

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

(a) The *Network Operator* 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 the *Network Operator* during an emergency in accordance with clause 4.3.5, the *Network Operator* is required to undertake a review under clause 5.8.11 and the *Network Operator* shall 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 the *Network Operator* may *disconnect* a *User's facilities* from a *network* if in the *Network Operator'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 the *Network Operator* will not be liable in any way for any loss or damage suffered or incurred by the *User* by reason of the *disconnection* and the *Network Operator* 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* shall not bring proceedings against the *Network Operator* to seek to recover any amount for any loss or damage described in clause 4.3.4(a).

(c) A User whose facilities have been disconnected under this clause 4.3.4 shall pay charges in accordance with the Network Pricing and Charges Schedule as if any *disconnection* had not occurred.

4.3.5 *Disconnection* during an Emergency

Where the *Network Operator* may *disconnect a User's facilities* during an emergency under this *Code* or otherwise, then the *Network Operator* may:

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

(b) immediately *disconnect* the *User's facilities* by automatic or manual means where, in the *Network Operator'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 Reconnect

The *Network Operator* shall *reconnect* a *User's facilities* to a *network* at a reasonable cost to the *User* as soon as practical if:

(a) a breach of this *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 process described in Section 1.5 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 the *Network Operator* 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 the *Network Operator* that the breach will not reoccur.

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 the *Network Operator* can 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 the *Network Operator* 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, the *Network Operator* 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* (49.8 Hz to 50.2 Hz*),* except for brief excursions within the *normal operating frequency excursion* band (49.5 Hz to 50.5 Hz) as specified by this *Code;*

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

(c) the current flows on all *lines* of the *network* are within the ratings (accounting for time dependency in the case of emergency ratings) as defined by the *Network Operator ;*

(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 the *Network Operator ;*

(e) the configuration of the *network* is such that the severity of any potential fault is within the capability of 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 *Network Operator'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), the *Network Operator* shall:

(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 the *Network Operator* considers the provisions of clause 5.2.2(a)(2) to be not satisfied, where:

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

(2) the *Users* connected to that part of the *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 *connection agreement* between that *User* and the *Network Operator* 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) The *Network Operator* shall 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 shall take into account matters including but not limited to:

(1) the *Network Operator* 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 *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 of or possible changes in *plant* availability.

5.2.4 General principles for maintaining *power system security*

The *Power System Controller* has the responsibility to maintain *power system security* as per design and operating limits determined by the *Network Operator*. The *power system security* principles are as follows:

(a) To the extent practical, 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, the *Power System Controller* 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 shall 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 the *Network Operator* for *power system security*

The *Network Operator 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 the *Network Operator* 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 the *Network Operator* deems appropriate, information of which the *Network Operator* 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 the *Network Operator ;*

(l) 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;

5.3.2 Responsibility of the *Power System Controller* for *power system security*

(a) 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;*

(b) 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;*

(c) 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;*

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

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

(f) to investigate and review all major *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.

5.3.3 *Network Operator's* obligations

(a) The *Network Operator* shall use its reasonable endeavours, including through the provision of appropriate information to *Users* to the extent permitted by law and under this *Code,* to achieve the *Network Operator 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 the *Network Operator* 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 the *Network Operator* to use reasonable endeavours, including to give such *directions* as are within its powers, to comply with that obligation.

(c) If the *Network Operator* fails to arrange or control any act, matter or thing or the acts of any other person notwithstanding the use of the *Network Operator's* reasonable endeavours, *Network Operator* will not be taken to have breached such obligation.

(d) The *Network Operator* shall make accessible to *Users* such information as:

(1) the *Network Operator* considers appropriate;

(2) the *Network Operator* is permitted to disclose in order to assist *Users* to make appropriate market decisions related to open access to the *Network Operator's networks*; and

(3) the *Network Operator* is able to disclose to enable *Users* to consider initiating procedures to manage the potential risk of any necessary action by the *Network Operator* to restore or maintain *power system security,*

provided that, in doing so, the *Network Operator* shall 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 the *Network Operator ,* in its reasonable opinion for reasons of safety to the public, the *Network Operator* personnel, *Users'* equipment or the *Network Operator* equipment or for *power system security,* needs to interrupt *supply* to any *User,* the *Network Operator* will (time permitting) consult with the relevant *User* prior to executing that interruption.

(f) The *Network Operator* shall 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 the *Network Operator's* opinion, a prolonged major *power system* disruption.

5.3.4 *User* obligations

(a) All *Users* shall co-operate with and assist *Network Operator* in the proper discharge of the *Network Operator power system security responsibilities.*

(b) All *Users* shall operate their *facilities* and equipment in accordance with any reasonable *direction* given by the *Network Operator .*

(c) All *Users* shall 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 the *Network Operator* in accordance with clause 2.6.

(d) *User's* shall provide their *interruptible load* in manageable blocks spread over a number of steps within under-*frequency* bands from 49.25 Hz down to 48.50 Hz as nominated by the *Network Operator.*

5.4 *POWER SYSTEM* FREQUENCY CONTROL

5.4.1 *Power system* frequency control responsibilities

The *Power System Controller* shall 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 the *Power System Controller* the following provisions apply:

(a) The power to control and direct the output of all *generating units* and supply to *loads* is given to the *Power System Controller* pursuant to clause 5.9.

(b) Each *User* shall 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) The *Power System Controller* shall use its reasonable endeavours to arrange to be available and specifically allocated to *regulating duty* such *generating plant* as the *Power System Controller* considers appropriate which can be automatically controlled or directed by the *Power System Controller* to ensure that normal *load* variations do not result in *frequency* deviations outside the limitations specified in clause 5.2.1(a).

(d) The *Power System Controller* shall 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*loading* 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) The *Power System Controller* shall use its reasonable endeavours to ensure that adequate *facilities* are available and are under the *direction* of the *Power System Controller* to allow the managed recovery of the *satisfactory operating state* of the *power system.*

5.5 CONTROL OF *NETWORK VOLTAGES*

5.5.1 *Network voltage* control

(a) The *Network Operator* shall determine the adequacy of the capacity to produce or absorb *reactive power* in the control of the *network voltages.*

(b) The *Network Operator* shall assess and determine the limits of the operation of the *network* associated with the avoidance of *voltage* failure or collapse under *credible contingency event* scenarios.

(c) The limits of operation of the *network* shall be translated by the *Network Operator ,* into key location operational *voltage* settings or limits, *power line* capacity limits, *reactive power* production (or absorption) capacity or other appropriate limits to enable their use by the *Network Operator* in the maintenance of *power system security.*

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

(e) The *Power System Controller* shall use its reasonable endeavours to maintain *voltage* conditions throughout the *network* in accordance with the technical requirements specified in Section 2.

(f) The *Network Operator* shall 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 the *Network Operator.*

(g) Without limitation, such *reactive power facilities* may include:

(1) *synchronous generator voltage controls* usually associated with *tap-changing transformers;* or *generator* AVR set point 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) The *Network Operator* shall 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 the *Network Operator.*

(b) If *voltages* are outside acceptable limits, and the means of *voltage* control set out in this clause *5.5* are exhausted, the *Network Operator* shall 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* shall comply with any such *direction.*

5.5.3 Audit and testing

The *Network Operator* shall 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) The *Network Operator* shall determine the fault levels at all *busbars* of the *Network Operator's network* as described in clause 5.6.1 (b);

(b) The *Network Operator* shall ensure that there is information available about the *network* which will allow the determination of fault levels for normal operation of the *power system.* The *Network Operator* will make available on request the *credible contingency events* which the *Network Operator* considers may affect the configuration of the *power system* so that the *Network Operator* 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

The *Network Operator* shall use its reasonable endeavours to co-ordinate the *protection* settings for equipment connected to the *network. Users* with *protection* systems that impact *power system security* and *reliability* shall ensure their settings co-ordinate with the *Network Operator's protection.* Such *Users* may not adjust settings without the *Network Operator's* approval. Specific requirements are described in clauses 3.4.2.15 and 4.2.3.

5.6.3 Audit and testing

The *Network Operator* shall use its reasonable endeavours to co-ordinate such inspections and tests as *Network Operator* thinks appropriate to ensure that the *protection* of the *network* is adequate to protect against damage to *power system plant* and equipment. Such tests shall be performed according to the requirements of clause 4.1.

5.6.4 Short-term thermal ratings of the *power system*

(a) The *Network Operator* may act so as to use, or require or recommend actions which use the full extent of the thermal ratings of *network elements* to maintain *power system security,* including the short-term ratings (being time dependent ratings), as defined by the *Network Operator* from time to time.

(b) The *Power System Controller* shall use its reasonable endeavours not to exceed the *network 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 *network element,* the *Power System Controller* shall determine, the most appropriate action. Depending on the circumstances the determination may be:

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

(2) to take the *network 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 *network element* at a lower capacity.

(b) If there is an *outage* of both *protection schemes* on a *network element* and the *Power System Controller* determines this to be an unacceptable risk to *power system security,* the *Power System Controller* shall take the *network element* out of service as soon as possible and advise any affected *Users* immediately this action is undertaken.

(c) Any affected *User* shall accept a determination made by the *Network Operator* under this clause 5.6.5.

5.7 *POWER SYSTEM* STABILITY CO-ORDINATION

5.7.1 Stability analysis co-ordination

(a) The *Network Operator* shall 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) The *Network Operator* shall facilitate establishment of the parameters and endorse the installation of *power system* devices which are approved by the *Network Operator* to be necessary to assist the stable operation of the *power system.*

5.7.2 Audit and testing

The *Network Operator* shall 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* shall promptly advise the *Network Operator* 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* shall advise the *Network Operator* . If the *Network Operator* considers it to be a threat to *power system security,* the *Network Operator* may direct that the equipment protected or operated by the relevant *protection* or *control system* be taken out of operation or operated as the *Network Operator* directs.

(b) A *User* shall comply with a *direction* given by the *Network Operator* under clause 5.8.2(a) at no cost to the *Network Operator.*

5.8.3 *Network Operator's* advice on *power system* emergency conditions

(a) The *Network Operator* shall advise affected or potentially affected *Users* of all relevant details promptly after the *Network Operator* becomes aware of any circumstance with respect to the *power system* which, in the reasonable opinion of the *Network Operator* 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 are insufficient *network* 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) a *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* the *Power System Controller* shall 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 *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, the *Power System Controller* shall follow the procedures outlined in clause 5.8.

5.8.5 Managing electricity supply shortfall events

(a) If, at any time, there are insufficient *supply* options available to securely *supply* total *load* in a *region,* then, the *Power System Controller* may undertake all or any of the following:

(1) recall of equipment *outages;*

(2) *disconnect* one or more points of *load connection* as the *Power System Controller* considers necessary;

(3) direct a *User* to take such steps as are reasonable to immediately reduce its *load.*

(b) A *User* shall 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, the *Power System Controller* shall implement, to the extent practical, a sharing of *load shedding* across *interconnected regions* up to the *power transfer capability* of the *network.*

5.8.6 *Directions* by the *Network Operator* affecting *power system security*

Subject to the *Network Operator* giving a *User* a reasonable period of time to take appropriate action:

(a) The *Network Operator* may give reasonable *directions* to any *User:*

(1) requiring the *User* to do any act or thing which the *Network Operator* 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* shall use all reasonable endeavours to comply within a reasonable period of time with any such *directions* given to it by the *Network Operator .* 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, the *Network Operator* may *disconnect* the *User* without further recourse.

See also Section 7.3 of the System Control Technical Code.

5.8.7 *Disconnection* of generating units and/or *associated loads*

(a) Where, under this *Code* or the relevant *access agreement* the *Network Operator* 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* shall provide all reasonable assistance to the *Network Operator* for the purpose of such *disconnection.*

5.8.8 Emergency black *start-up facilities*

Users shall ensure they have sufficient *facilities* available and operable for their own black start-up requirements.

5.8.9 Local black system procedures

(a) A *User* shall develop the draft *black system procedures* for each of its *power stations* and shall submit those procedures for approval by the *Network Operator* in consultation with the *Power System Controller*.

(b) The *Network Operator* may request amendments to a *User's* draft *black system procedures* or any proposed changes as the *Network Operator* reasonably considers necessary by notice in writing to the *User,* where use is to be made of the *network.*

(c) If the *Network Operator* and a *User* are unable to agree on the amendments, the matter may be dealt with under the dispute resolution process described in Section 1.5.

5.8.10 Black system start-up

(a) The *Power System Controller* shall advise a *User* if, in the *Power System Controller'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* shall be consistent with this *Code* and their *access agreements.*

(c) The *Network Operator* 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*.

(d) If the *Power System Controller* 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* shall comply with the agreed requirements of the *local black system procedures.*

(e) If there is a *black system* condition, then a *User/Customer* shall comply with the *Power System Controller's* instructions with respect to the timing and magnitude of *load* restoration, as well as subsequent *load* movements or *disconnections.*

5.8.11 Review of operating incidents

(a) The *Network Operator* shall 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 the *Network Operator* has been responsible for the *disconnection* of a *User,* the *Network Operator* shall provide a report of the review carried out to the *User* advising of the circumstances requiring that action.

(c) A *User* shall co-operate in any such review conducted by the *Network Operator* (including making available relevant records and information).

(d) A *User* shall provide to the *Network Operator* such information relating to the performance of its equipment during and after particular *power system* incidents or operating condition deviations as the *Network Operator* reasonably requires for the purposes of analysing or reporting on those *power system* incidents or operating condition deviations.

(e) The *Network Operator* shall 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 the *Network Operator* 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* shall 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 the *Power System Controller;* or

(3) as a consequence of operation of the *generating unit's* automatic *load* following scheme approved by the *Network Operator ;* or

(4) in accordance with a procedure agreed with the *Network Operator;* or

(5) in connection with a test conducted in accordance with the requirements of this *Code* or a procedure agreed with by the *Network Operator;*

(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 the *Network Operator ;* or

(2) in response to remote control signals given by the *Network Operator* 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 the *Network Operator* and conducted in accordance with this *Code* or procedures agreed with the *Network Operator.*

(c) *energise* a *connection point* in relation to a *User's generator unit* without prior approval from the *Network Operator.* This approval shall 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 the *Power System Controller* 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 the *Network Operator ;* or

(f) remove from service or interfere with the operation of any *power system* stabilising equipment installed on that *generating unit.*

See also Sections 3.9 and 4.3 of the System Control Technical Code.

5.9.2 Commitment of generating units

In relation to any *User's generating unit,* the *User* shall confirm with the *Power System Controller*, the expected *synchronism* time at least one hour before the expected actual *synchronising* time, and update this advice 5 minutes before *synchronising* unless otherwise agreed with the *Power System Controller.* The *Power System Controller* 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 a Generator or the Network Operator shall notify the *Power System Controller* 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 the *Power System Controller* .

(b) A *User* shall confirm with the *Power System Controller* 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 the *Power System Controller* . The *Power System Controller* may require further notification immediately before *de-synchronisation.*

(c) Information to be confirmed with the *Power System Controller* to *de-commit* a *User's generating unit* if there is to be no automatic and coincident reduction in the *User's associated load* shall 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 shall 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 shall be obtained from the *Power System Controller* before commencing this exercise.

5.9.4 *User plant* changes

A User shall, without delay, notify the *Power System Controller* 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 this *Code* and any applicable *access agreement*.

5.10 *POWER SYSTEM* OPERATING PROCEDURES

5.10.1 *Power system* operating procedures

The *power system operating procedures* are:

(a) any instructions which may be issued by the *Power System Controller* from time to time relating to the operation of the *power system;* and

(b) any guidelines issued from time to time by the *Power System Controller or Network Operator* in relation to *power system security.*

5.10.2 *Network* operations

(a) The *Power System Controller* shall conduct or direct operations on the *network* in accordance with the appropriate *power system operating procedures* and *good electricity industry practice.*

(b) A *User* shall observe the requirements of the relevant *power system operating procedures.*

(c) *Users* shall operate their equipment interfacing with the *network* in accordance with the requirements of this *Code,* any applicable *access agreement, ancillary services agreement* and the *Network Operator's* Electrical Safety Manual.

(d) *Users* shall ensure that *network* operations performed on their behalf are undertaken by competent persons.

5.10.3 Switching of reactive *power facilities*

(a) The *Power System Controller* 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 the *Network Operator* and a *User.*

(b) Without limitation to its obligations under such prior arrangements, a *User* shall use reasonable endeavours to comply with such an instruction given by the *Network Operator* 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, shall be installed and maintained by a *User* in accordance with the standards and protocols determined and advised by the *Power System Controller* (for use in the *Power System Controller's control centre)* for each:

(1) *generating unit* and *associated load connected* to the *network;*

(2) *zone substation connected* to the *network*; and

(3) *ancillary service* provided by that *User.*

(b) The provider of any *ancillary services* shall arrange the installation and maintenance of all *remote control equipment* and *remote monitoring equipment* in accordance with the standards and protocols determined by the *Power System Controller* for use in the *Power System Controller's control centre.*

(c) The controls and monitoring devices shall 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 *network,* and the *User's plant* active and reactive output consumption.

5.11.2 Operational control and indication communication *facilities*

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* shall provide and maintain the necessary primary and, where nominated by the *Network Operator ,* back-up communications *facilities* for control, operational *metering* and indication from the relevant local sites to the appropriate interfacing termination as nominated by the *Network Operator .*

5.11.3 *Power system* voice/data operational communication *facilities*

(a) *Users* shall advise the *Power System Controller* of each nominated position for the purposes of giving or receiving *operational communications* in relation to each of its *facilities.* The position so nominated shall be that responsible for undertaking the operation of the relevant equipment of the relevant *User.*

(b) Contact personnel details which shall be forwarded to the *Power System Controller* 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* shall provide, for each nominated position, two independent telephone communication systems fully compatible with the equipment installed at the appropriate *control centre* nominated by the *Power System Controller .*

(d) Each *User* shall maintain both telephone communication systems in good repair and shall investigate faults within 4 hours, or as otherwise agreed with the *Power System Controller ,* of a fault being identified and shall repair or procure the repair of faults promptly.

(e) Each *User* shall establish and maintain a form of electronic mail facility as approved by the *Power System Controller* for communication purposes (such approval may not be unreasonably withheld).

(f) The *Power System Controller* shall advise all *Users* of nominated persons for the purposes of giving or receiving *operational communications.*

(g) Contact personnel details to be provided by the *Power System Controller* 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) The *Power System Controller* and *Users* shall 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 practical after making or receiving the *operational communication.*

(b) Records of *operational communications* shall include the time and content of each communication and shall identify the parties to each communication.

(c) Voice recordings of telephone *operational communications* may be undertaken by the *Power System Controller* and *Users.* The *Power System Controller* and the *User* shall 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

(d) The *Power System Controller* and *Users* shall 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 the *Power System Controller* 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 the *Power System Controller.*

(b) A *User* who has appointed a *User Agent* may replace that *User Agent* but only with the prior written advice to and consent of the *Power System Controller.*

(c) The *Power System Controller* 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 *network.*

(d) For the purposes of this *Code* and any applicable *access agreement* acts or omissions of a *User Agent* are deemed to be acts or omissions of the relevant *User.*

(e) The *Power System Controller* 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) The *Power System Controller* 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* shall use the *nomenclature standards* for *network* equipment and apparatus as agreed with the *Network Operator* or failing agreement, as determined by the *Network Operator.*

(b) A *User* shall use reasonable endeavours to ensure that its *representatives* comply with the *nomenclature standards* in any *operational communications* with the *Network Operator .*

(c) A *User* shall 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* shall 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* shall ensure that technical drawings and documentation provided to the *Network Operator* comply with the *nomenclature standards.*

(f) The *Network Operator* may, by notice in writing, request a *User* to change the existing numbering or nomenclature of *network* equipment and apparatus of the *User* for purposes of uniformity, and the *User* shall comply with such request provided that if the existing numbering or nomenclature conforms with the *nomenclature standards,* the *Network Operator* shall pay all reasonable costs incurred in complying with the request.

(g) All nomenclature shall be unique and unambiguous.

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 *revenue metering point* through which *energy* is transferred to or *energy* is taken from the *Network Operator's electricity network.*

6.1.2 Purpose of Metering Section

(a) The purpose of this section is to set out the rights and obligations of *Users* and the *Network Operator .*

(b) This section sets out provisions relating to:

(1) *revenue metering installations* used for the measurement of *active energy* and *reactive energy,* imported and/or exported;

(2) *check metering installations;*

(3) the collection of *revenue metering data;*

(4) the provision, installation and maintenance of equipment;

(5) the accuracy of *revenue metering equipment;*

(6) testing requirements;

(7) the security and rights of access to *revenue metering data* and equipment; and

(8) the provision of *revenue metering data.*

6.1.3 Principles of Metering Section

The key principles adopted in this section are that:

(a) each *connection point* shall have a *revenue metering installation;*

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

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

(d) the *Network Operator* will install the *revenue meters* or the *revenue metering,* and will commission and maintain the *revenue metering*.

(e) the *Network Operator* 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) the *Network Operator* will own the *revenue 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 *revenue metering installation* will be borne by the *User;*

(h) the *Network Operator* shall ensure that the accuracy of each component of a *revenue 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) the *Network Operator* will make *revenue metering data* available to each *User,* subject to confidentiality requirements;

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

(l) the specifications for the *revenue 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 *revenue metering data* is to be retained for a minimum of 7 years;

(n) the *Network Operator* will audit *revenue metering* when requested.

6.2 RESPONSIBILITY FOR METERING INSTALLATION

6.2.1 Responsibility of *the Network Operator*

(a) No later than 20 *business days* after receiving a request for the provision of a *revenue metering installation,* or a *revenue metering installation* and a *check metering installation* from a prospective *User,* the *Network Operator* 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 *revenue metering* components in accordance with Attachment 4 and the *Network Operator 's Metering Manuals, Underground Manual and Overhead Line Manual.*

(b) If the *User* accepts the offer, the *Network Operator* has the responsibility for the provision, installation, commissioning and maintenance of the *revenue metering* equipment in accordance with Attachment 4 and the *Network Operator's Metering Manuals, Underground Manual and Overhead Line Manual.*

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

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

(b) The *Network Operator* will provide and install the *revenue meters,* commission the installation and provide ongoing maintenance of the *revenue*

metering installation in accordance with Attachment 4 and the *Network Operator's Metering Manuals.*

6.2.3 Other Responsibilities

(a) The *Network Operator* shall ensure that the *revenue metering installation* is provided, installed and maintained in accordance with Attachment 4 and the *Network Operator's Metering Manuals.*

(b) The *User,* if providing and installing *revenue metering equipment,* shall ensure that the equipment complies with Attachment 4 and the *Network Operator's Metering Manuals* and that prior to installation, the equipment which is involved in measurement of energy, other than the *check meters,* is submitted to the *Network Operator* for testing for compliance with the *Network Operator's Metering Manuals.*

6.3 METERING INSTALLATION ARRANGEMENTS

6.3.1 Metering Installation Components

(a) A *revenue metering installation* shall 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 *revenue metering installation* shall:

(1) contain a measuring device for *active* and *reactive energy* and a visible display of all *revenue 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 the *Network Operator's Metering Manuals;*

(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 *revenue metering data* to a communication system; and

(8) include a communication system for two way communications with the *Network Operator .*

(c) A *revenue 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) *revenue meter* panels on which the *revenue meters* and communication equipment are mounted;

(5) communication equipment such as modem, Public Switched Telephone Network connection, isolation, radio transmitter and receiver, data link, or power line carrier equipment;

(6) test links and fusing;

(7) energy and status signals;

(8) summation equipment;

(9) *revenue metering* enclosure;

(10) marshalling boxes; and

(11) *revenue metering* unit.

(d) The *revenue metering installation* is exclusively for *revenue 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) *Revenue metering data* will be used by the *Network Operator* as the primary source of billing data.

(b) Where appropriate *check metering data* is available, it will be used by the *Network Operator* for:

(1) validation;
(2) substitution; and
(3) account estimation

of *revenue metering data* as required by clause 6.8.4.

6.3.3 Metering Type and Accuracy

(a) The accuracy for a *revenue metering installation* and the requirements for a *revenue metering installation* which shall be installed at each *revenue metering point* shall be in accordance with Attachment 4 and the *Network Operator's Metering Manuals.*

(b) A *check metering installation* is not required, but if provided by a *User* it may use the voltages and currents provided by the *revenue metering voltage transformers* and *current transformers.* The *check meter* or *check meters* will be of the same class as the *revenue meters.* If the *User* elects to provide separate *current transformers* and *voltage transformers* they shall comply with clause 6.2.3(b).

6.3.4 Data Collection System

(a) The *Network Operator* shall ensure that an appropriate communication system is installed to each *revenue metering installation.*

(b) The *Network Operator* shall establish processes for the collection of *revenue metering data* from each *revenue metering installation* for storage in a *revenue metering data base* in accordance with the *Network Operator's Metering Manuals.*

(c) The *Network Operator* may obtain *revenue metering data* directly from a *revenue 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 *revenue metering data,* processing and account resolution for a *revenue metering installation.*

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

6.4 REGISTER OF METERING INFORMATION

6.4.1 Metering Register

(a) As part of the *revenue metering database,* the *Network Operator* shall maintain a *revenue metering register* of all *User revenue metering installations* and *check metering installations* which provide tariff data.

(b) The *revenue metering register* for a particular *User's revenue metering installation* shall 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 *revenue metering register,* the *Network Operator* shall correct the discrepancy within 2 days.

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

6.5 TESTING OF METERING INSTALLATION

6.5.1 Responsibility for Testing

(a) Testing of a *revenue metering installation* shall be carried out in accordance with the *Network Operator's Metering Manuals.*

(b) A *User* may request the *Network Operator* to arrange for the testing of any *User's revenue metering installation* and the *Network Operator* shall not refuse any reasonable request.

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

(d) The *Network Operator* shall arrange for sufficient audit testing of *User revenue metering installations* to satisfy itself that each *revenue metering installation* conforms to the requirements of this section.

(e) The *Network Operator* shall have unfettered access to any *User's revenue metering installation* at any time for the purpose of testing the *revenue metering installation.*

6.5.2 Actions in Event of Non-Compliance

(a) If a *revenue metering installation* does not comply with the requirements of this section, the *Network Operator* shall as soon as practical advise the *User* and arrange for the *revenue metering installation* to be made compliant with the requirements of this section.

(b) The *Network Operator* shall in conjunction with the *User* make appropriate corrections to the *revenue 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 the *Network Operator* to conduct an audit to determine consistency between the data held in the *revenue metering database* and the *revenue metering data* held in the *User's revenue metering installation.*

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

6.6 RIGHTS OF ACCESS TO DATA

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

(1) the *Network Operator*; and
(2) the *User* whose account statement relates to energy measured at that *revenue metering point.*

(b) Electronic access to *revenue metering data* from a *revenue metering installation* shall only be provided where appropriate multi-level password *revenue 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

The *Network Operator* is responsible for the security of the *revenue metering installation* and will fit seals or other devices to prevent or disclose unauthorised access.

6.7.2 Security Controls

(a) The *Network Operator* is responsible for the security of *revenue metering data* held in the *revenue 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) The *Network Operator* shall keep records of electronic passwords secure.

(c) The *Network Operator* may allocate "read-only" passwords to *User's* where

the *revenue meters* installed have provision for multi-level passwords.

6.7.3 Changes to Metering Equipment, Parameters and Settings

The *Network Operator* shall record all changes to *revenue metering* equipment, parameters and settings.

6.8 PROCESSING OF METERING DATA FOR SETTLEMENT PURPOSES

6.8.1 Metering Databases

(a) The *Network Operator* will create, maintain and administer a *revenue metering database* containing information for each *User revenue metering installation.*

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

6.8.2 Remote Acquisition of Data

(a) The *Network Operator* is responsible for the remote acquisition of *revenue metering data* and for storing and processing this data for *settlement* purposes.

(b) If remote acquisition becomes unavailable, the *Network Operator* is responsible for obtaining the relevant *revenue metering data* from the *revenue meters.*

6.8.3 Periodic Energy Metering

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

6.8.4 Data Validation and Substitution

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

(b) *Check metering data*, where available, may be used by the *Network Operator* to validate *revenue metering data* provided that the *check metering data* has been appropriately adjusted for differences in *revenue metering installation* accuracy.

(c) For the purpose of *settlement, check metering data,* if available, may be substituted either in whole or part for some or whole of the *revenue metering* readings.

(d) If a *check meter* is not available or *metering data* cannot be recovered from the *metering installation* within the time required for *settlements*, then a substitute value is to be prepared by the *Network Operator* using a method agreed with the *User*.

6.8.5 Errors Found in Metering Tests, Inspections or Audits

(a) If a *revenue metering installation* test, inspection or audit demonstrates that a

component of the *revenue 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 the *Network Operator's Metering Manuals.*

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

6.8.6 Load Following and Out of Balance Energy

The *Network Operator* shall forward metering data to the *Power System Controller* for load following reconciliation and out of balance energy settlement.

6.9 CONFIDENTIALITY

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

6.10 METER TIME

(a) All *revenue metering installation* clocks are to be referenced to Australian Central Standard *Time* and maintained to a standard of accuracy as required by AS 1284.

(b) The *revenue metering database* shall be set within an accuracy of ±10 seconds of Australian Central 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 the *Network Operator* determines shall continue beyond a specific transition period; and

(3) providing specific exemptions from the *Code* for future arrangements which the *Network Operator* determines to be acceptable.

(d) Applications for *derogations* shall be submitted to and processed by the *Network Operator* in accordance with The Electricity Networks (Third Party Access) Act 1999*.*

7.2 NETWORKS AND FACILITIES EXISTING AT 1 APRIL 2000

All *plant* and equipment in the *Network* and all *facilities* connected to this *network* existing at 1 April 2000 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 OF TERMS

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 Power and Water Act 1987 has the meaning given in that Act unless redefined in the table below.

access agreement	Means a contract or agreement for the provision of network access services entered into between a *network provider* and a network *user* under the *Code*, and includes an award made by an arbitrator for the same purpose.
access application	An access application made under clause 10 of the *Code*, which is detailed in Attachment 6.
access services	The following services: *use of system services; common services; connection services* and *ancillary services.*
active energy	A measure of electrical energy flow, being the time integral of the product of *voltage* and the in-phase component of current flow across a *connection* point, expressed in Watt-hours (Wh) and multiples thereof.
active power	The rate at which *active energy* is transferred.
active power capability	The maximum rate at which *active energy* may be transferred from a *generating unit* to a *connection point* as specified in 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	The following services: *voltage control, reactive power* control*, frequency* control, *control system services, spinning reserve* and *post-trip management*.
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	In relation to the *electricity network*, means to enlarge or expand the capability of the *electricity network* to accept, transport and deliver electricity.
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 *power 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 *power line.*

backup 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 *network* following a major *supply* disruption, affecting one or more *power stations* and a significant number of customers.
breaker fail protection	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 when it is required to open.
busbar	A common *connection point* in a *power station substation* or a *transmission network substation.*
business day	Any day other than a Saturday, Sunday, or day that is a public holiday in the City of Darwin.
capacitor bank	A type of static electrical equipment used to generate *reactive power* and therefore support *voltage* levels on *network elements.*
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 metering installation	A *metering installation* which may be used as a source of *metering data* for validation, substitution or account estimation as provided in Clause 6.
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*.
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.*
common services	A network service that ensures the integrity of the *electricity network* and benefits all *users* and that cannot be practically ~~be~~ allocated to *users* on a locational basis.
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, connection	Means to establish an effective link via installation of the necessary connection equipment.
connection agreement	An agreement between the *Network Operator* and one or more *Users* in respect of the connection under which the *User or Users* agree to comply with the *Technical Code* and any relevant legislation.
connection asset	Means all of the electrical equipment that is used only in order to transfer electricity to or from the electricity network at the relevant connection point and includes any transformers or switchgear at the relevant point or which is installed to support or to provide backup to such electrical equipment as are necessary for that transfer.
connection point	A point at which electricity is transferred to or from an electricity network.
connection services	In relation to a connection point, means the establishment and maintenance of that connection point.
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 the *Network Operator* expects would be likely to involve the failure or removal from operational service of a *generating unit* or *network element.*
control centre	*The facility* used by the *Power System Controller* for directing the minute to minute operation of the *power system.*
controller	A person employed by a *Power System Controller* engaged in the activities of controlling the transfer of *electrical energy* at a *connection point*.
control system	Means of monitoring and controlling the operation of the *power system* or equipment including *generating units connected* to a *network.*
control system services	The 24-hour control of the power system through monitoring, switching and dispatch which is provided through control centres and SCADA and communication equipment.
credible contingency	A *contingency event* the occurrence of which the *Network*

event	*Operator* 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 the *Network Operator* , in 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 *network element* on the *power system.* However, this may involve the consideration by the *Network Operator* 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 *power 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 purchases electricity *supplied* through a *network.*
day	Unless otherwise specified, the 24 hour period beginning and ending at midnight Australian Central Standard Time.
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 *protection schemes* 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 the *Network Operator or Power System Controller* to any *User* requiring the *User* to do any act or thing which the *Network Operator or Power System Controller* 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	In respect of a connection point, means to operate switching equipment so as to prevent the transfer of electricity through the *connection point.*

dispatch	The act of committing to service all or part of the generation available from a *scheduled generating unit.*
distribution network	That part or those parts of the electricity network used for transporting electricity at nominal voltages of less than 66kV and at a nominal frequency of 50Hz.
dynamic performance	The response and behaviour of *networks* and *facilities* which are *connected* to the *networks* when the normal *operating state* of the *power system* is disturbed.
electrical energy loss	*Energy* loss incurred in the production, transportation and/or use of electricity.
electricity network	The connection assets and network system assets which together are operated by the network provider for the purposes of transporting electricity from generators of electricity to a transfer point or to consumers of electricity.
electricity transmission capacity	The capacity of the transmission *network* to transmit power between two or more points under the full range of operating conditions likely to be experienced in service.
transmission network	That part or those parts of the electricity network used for transmitting electricity at nominal voltages of 66kV or higher and at a nominal frequency of 50Hz.
embedded generator	A *generator* which supplies on-site *loads* or *distribution network loads* and is *connected* either indirectly (ie. via the *distribution network)* or directly to the *transmission network.*
energise/energisation	The act of operation of switching equipment or the start-up of a *generating unit,* which results in there being a non-zero *voltage* beyond *a connection point* or part of the *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 a *generating unit* (including excitation limiting devices and any *power system stabiliser*).
extension	The capital investment associated with the designing, constructing, installing and commissioning of the electricity network assets required to connect a User to the electricity 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 *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 frequency standards set out in 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 electrical *energy* ~~y~~ 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, generator	An electricity generator, and related equipment essential to the generator's operation, which supplies electricity into an electricity network and together function as a single entity.
generation	The production of electrical *energy* 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, (when referring to a person)	A person who engages in the activity of owning, controlling, or operating a *generating system* that *supplies* electrical *energy* to, or who otherwise *supplies* electrical *energy* to, a *transmission network* or *distribution network.*
good electricity industry practice	The exercise of that degree of skill, diligence, prudence and foresight that reasonably would be expected from a significant proportion of operators of facilities forming part of a power system for the generation, transmission distribution and supply of electricity comparable to those applicable to the relevant facility consistent with applicable laws, the Access Code, the *Technical Code,* licences, industry codes, reliability, safety and environmental protection.
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,	A *transmission line* or group of *transmission lines* that connects the *transmission networks* in adjacent *regions.*

interconnected	
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 the *Power System Controller* to cater for *contingency events* or shortages of *supply*
intra-regional	Within a *region.*
load	The amount of electrical energy delivered at a defined instant at a connection point or aggregated over a group of connection points.
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 procedures approved by the *Power System Controller* 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* are those which will prevail with the maximum number of *generators* and network elements normally connected at times of maximum *generation.*
metering equipment	Equipment used to measure and record the rate at which electricity is transferred and the quantity of electricity transferred to and from the network.
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* are those which will prevail with the least number of *generators* and network elements 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 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 calendar month", then the end date in the "next calendar 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 network.*
network capability	The capability of the *network* or part of the *network* to transfer electrical *energy* from one location to another.
network losses	The energy loss incurred in the transportation of electricity from an entry or transfer point to an exit point or another transfer point on an electricity network.
Network Operator	A body defined as a "network provider" in the Electricity Networks (Third Party Access) Act 1999
network planning criteria	Criteria consistent with this *Code* prepared by the *Network Operator* which include the following: contingency criteria; steady-state criteria; stability criteria (transient, dynamic, voltage, and frequency); quality of supply criteria (voltage limits, voltage fluctuation, system frequency, harmonic voltage, harmonic current, voltage unbalance, electro-magnetic interference) and environmental criteria.
nomenclature standards	The standards approved by the *Network Operator* relating to numbering, terminology and abbreviations used for information transfer by *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 the *Network Operator* 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).
operational communication	A communication concerning the arrangements for, or actual operation of the *power system* in accordance with the *Code.*
outage	Any planned or unplanned full or partial unavailability of *plant* or equipment.
peak load	Maximum *load.*
plant	Includes all equipment involved in generating, utilising or transmitting electrical *energy.*
post-trip management	The maintenance of system security in the aftermath of trips.
Power and Water Corporation	The body corporate established under the Government Owned Corporations Act 2001.
***Network Operator's* Metering Manuals**	Specifications prepared by the *Network Operator* for equipment including *revenue metering* and communications enclosures, indoor and outdoor *revenue metering* units (VTs

	and CTs plus enclosure), CTs, VTs, marshalling boxes and wiring.
Power system security responsibilities	The responsibilities described in clause 5.3.1.
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 generation facilities and electricity network facilities which together are integral to the supply of electricity, operated as an integrated arrangement.
Power System Controller	See definition in the Electricity Networks (Third Party Access) Act 1999.
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 system stabiliser	An auxiliary control device connected to an *excitation control system* to provide additional feedback signals to reduce *power system* oscillations.
power transfer	The instantaneous rate at which *active energy* is transferred between *connection points.*
power transfer capability	The maximum permitted *power transfer* through a *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 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	Refers to, 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 electrical power 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 electrical *power* 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 power lines; (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 *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 *voltage* effects during these periods.
region, regional	An area determined by the *Network Operator,* being an area served by a particular part of the *transmission network* containing one or more major *load centres* or *generation centres* or both.
regulating duty	In relation to a *generating unit,* the duty to have its generated output adjusted frequently so that any *power system frequency* variations can be corrected.
reliability	The probability of a system, device, *plant* or equipment performing its function adequately for the period of *time* intended, under the operating conditions encountered.
reliable	The expression of a recognised degree of confidence in the certainty of an event or action occurring when expected.
remote back up protection	Refers to the detection and initiation of tripping at a location other than that at which the main *protection scheme* of the faulted *plant* is located. *Remote back up protection*

	provides a means of detecting and initiating clearance of *small zone faults* or fault contributions supplied via failed circuit breakers.
remote monitoring equipment (RME)	Equipment installed to enable monitoring of a *facility* from a *control centre,* including a remote terminal unit *(RTU).*
representative	In relation to a person, any employee, agent or *Consultant* of: (a) that person; or (b) a *related body corporate* of that person; or (c) a third party contractor to that person.
r**eserve**	The *active power* and *reactive power* available to the *power system* at a nominated *time* but not currently utilised.
revenue 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 *revenue metering data.*
revenue metering installation	A *metering installation* used for recording the production or consumption of electrical *energy.*
revenue metering data	The data obtained from a *revenue metering installation,* the processed data or substituted data.
revenue metering database	A database of *revenue metering data.*
revenue metering point	The point of physical *connection* of the device measuring the current in the power conductor.
revenue metering register	A register of information associated with a *revenue metering installation* as required by clause 6.4.
revenue metering system	The collection of all components and arrangements installed or existing between each *revenue metering point* and the *revenue metering database.*
RTU	A Remote Terminal Unit installed within a substation or generating station to enable monitoring and control of a facility from a control centre.
satisfactory operating state	In relation to the *power system,* has the meaning given in clause 5.2.1.
SCADA system	Supervisory control and data acquisition equipment which enables the *Power System Controller* 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 the *Power System Controller.*
secondary equipment, secondary plant	Those assets of a *facility* and the *electricity 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.*
single contingency	In respect of a *network,* a sequence of related events which result in the removal from service of one *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.*
spare network capacity	The capacity to transport electricity over a particular electricity network which the network provider assesses is in surplus to the capacity that existing end-use customers forecast will be required to satisfy their reasonably foreseeable requirements for the transport of electricity.
spinning reserve	The ability to immediately and automatically increase generation or reduce demand in response to a fall in frequency.
standby power	The amount of electrical energy which could be supplied to a load user in accordance with the terms of a standby generation agreement.
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 *network.*
sub-network	A particular portion of the *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 excitation current.
synchronous generator voltage control	The automatic *voltage control system* of a *generating unit* of the sy*nchronous generator* category which changes the output *voltage* of the *generating unit* through the adjustment of the generator excitation 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 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 and which is used as a major component in the control of the *voltage* of *the networks* in conjunction with the operation of *reactive plant.*
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 *protection* equipment.
time	Central Australian Standard Time, as defined 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 electrical *energy*.
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 scheme* that results in alarming for loss of integrity of the *protection scheme's* trip circuit. *Trip circuit supervision* supervises a *protection scheme's* trip supply together with the integrity of associated wiring, cabling and circuit breaker trip coil.
trip supply supervision	A function incorporated within a *protection scheme* that results in alarming for loss of trip supply.
two fully independent protection schemes of differing principle	Where an item of *plant* is required to be protected by *two fully independent protection schemes of differing principle,* such *protection schemes* 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 scheme* would need to have its own independent battery and battery charger system supplying all that *protection scheme's* trip functions. The *protection schemes* 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	A person, whether a load user or a generator user, who has been granted access to the electricity network by the *Network Operator* in order to transport electrical energy to or from a particular point.
use of system services	A network service provided to a user for use of the electricity network for the transportation of electrical *energy* that can be reasonably allocated to a user on a locational basis.

voltage	The electronic force or electric potential between two points that gives rise to the flow of electrical *energy*.
voltage control	Keeping network voltages within operational limits in normal operation and in the aftermath of trips by automatic regulation of generation MVAr output or by voltage control equipment such as capacitor banks and automatic tap-changers.
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.

ATTACHMENT 2 - RULES OF INTERPRETATION

Subject to the Interpretation Act, this *Code* shall 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 shall occur on a day which is not a *business day* then the event shall 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 the *Network Operator* 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 the *Network Operator*; 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 the *Network Operator.* 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 the *Network Operator* at the time of assessment of a *network 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, for example by testing.

Preliminary system planning data

This is data required for submission with the *access application,* to allow the *Network Operator* 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.

The *Network Operator* 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 shall 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* as a provision of access, from manufacturers' data, detailed design calculations, works or site tests, etc (R1); and data derived from on-system testing after *connection* (R2).

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

A3.3 Data will be subject to review at reasonable intervals to ensure its continued accuracy and relevance. The *Network Operator* shall initiate this review. A *User* may *change* any data item at a time other than when that item would normally be reviewed or updated by submission to the *Network Operator* 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 the *Network Operator.*

(c) Schedule S3 - *Network* and *Plant* Technical Data. This comprises fixed electrical parameters.

(d) Schedule S4 - *Plant* and Apparatus Setting Data. This comprises settings which can be varied by agreement or by *direction* of the *Network Operator.*

(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,* shall be given exemption from complying with those parts of schedules S1 and S2 that are determined by the *Network Operator* to be not relevant to such *generating units,* but shall comply with those parts of Schedules S3, S4, and S5 that are relevant to such *generating units,* as determined by the *Network Operator.*

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)	S, D
VT	Nominal Terminal *Voltage*	kV	S, 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,

Symbol	Data Description	Units	Data Category
			R2
RF	Rotor resistance at 20° C	ohms	S, 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	S, D, R1, R2
XQ'	Quadrature Axis Transient Reactance	% on MBASE	S, D, R1, R2
XQ"	Quadrature Axis Sub-Transient Reactance	% on MBASE	S, D, R1, R2
XL	Stator Leakage Reactance	% on MBASE	S, D, R1, R2
XO	Zero Sequence Reactance	% on MBASE	S, D, R1
X2	Negative Sequence Reactance	% on MBASE	S, D, R1
XP	Potier Reactance	% on MBASE	S, 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	S, D, R1, R2
TQO'	Quadrature Axis Open Circuit Transient	Seconds	S, D, R1, R2
TQO"	Quadrature Axis Open Circuit Sub-Transient	Seconds	S, D, R1, R2
	Charts:		
GCD	Capability Chart	Graphical data	S, 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

Symbol	Data Description	Units	Data Category
	Generating Unit Transformer:		
GTW	Number of windings	Text	S, D
GTR_n	Rated MVA of each winding	MVA	S, D, R1
$GTTR_n$	Principal tap rated *voltages*	kV/kV	S, D, R1
$GTZl_n$	Positive Sequence Impedances (each wdg)	(a + jb)% on 100 MVA base	S, D, R1
$GTZ2_n$	Negative Sequence Impedances (each wdg)	(a + jb)% on 100 MVA base	S, D, R1
$GTZ0_n$	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	%	S, D
	Tap Changer Type, On/Off load	On/Off	S, D
	Tap Change Cycle Time	Seconds	D
GTVG	Vector Group	Diagram	S, D
	Earthing Arrangement	Text, diagram	S, D
	Saturation curve	Diagram	R1
	Generating Unit Reactive Capability (At machine terminals):		
	Lagging *Reactive Power* at PMAX	MVAr export	S, D, R2
	Lagging *Reactive Power* at ML	MVAr export	S, D, R2
	Lagging Reactive Short Time	MVAr	D, R1, R2
	capability at rated MW, terminal	(for time)	
	voltage and speed		
	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
	Maximum Field *Voltage*	V	S, D, R1
	Minimum Field *Voltage*	V	S, D, R1
	Maximum rate of change of Field *Voltage*	Rising V/s	S, D, R1
	Maximum rate of change of Field *Voltage*	Falling V/s	S, D, R1
	Generating Unit and exciter Saturation Characteristics 50 - 120%	Diagram	S, D, R1

Symbol	Data Description	Units	Data Category
	Dynamic Characteristics of Over *Excitation* Limiter	Text/ Block diagram	S, D, R2
	Dynamic Characteristics of Under *Excitation* Limiter	Text/ Block diagram	S, 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* Deadband	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. Format to be compatible with PTI (PSS/E) software.	Diagram	S, 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 the *Network Operator.*

SCHEDULE S2 - GENERATING UNIT SETTING DATA

Description Category	Units	Data Category
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 Stator E/F Rotor E/F Out of step	Text Text Text Text	D D D D
Control Data:		
Details of *excitation control system* described in block diagram form showing transfer functions of individual elements, parameters and measurement units (in PTI (PSS/E) format).	Text, diagram	S, D, R1, R2
Automatic voltage regulator	Text, diagram	S, D, R1, R2
Power system stabiliser	Text, diagram	S, 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 (in PTI (PSS/E) format).	Text, diagram	S, D, R1, R2
Over excitation limiter	Text, diagram	S, D
Under excitation limiter	Text, diagram	S, D
Stator current limiter (if fitted)	Text, diagram	S, D
Manual restrictive limiter (if fitted)	Text	S, D
Load drop compensation/VAr sharing (if fitted)	Text, function	S, D
V/f limiter (if fitted)	Text, diagram	S, D

SCHEDULE S3 - NETWORK AND PLANT TECHNICAL DATA OF EQUIPMENT AT OR NEAR CONNECTION POINT

Description	Units	Data Category
Voltage Rating		
Nominal *voltage*	kV	S, D
Highest *voltage*	kV	D
Insulation Co-ordination		
Rated lightning impulse withstand *voltage*	kVp	D
Rated short duration power *frequency* withstand *voltage*	kV	D
Rated Currents		
Circuit maximum current	kA	S, D
Rated Short Time Withstand Current	kA for seconds	D
Ambient conditions under which above current applies	Text	S,D
Earthing		
System Earthing Method	Text	S, D
Earth grid rated current	kA for seconds	D
Insulation Pollution Performance		
Minimum total creepage	mm	D
Pollution level	Level of *IEC* 815	D
Controls		
Remote control and *data transmission arrangements*	Text	D
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 *voltages*	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

Description	Units	Data Category
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 *generating units,* all connecting lines/cables, *transformers* etc.		
Series Resistance (+ve, -ve & zero seq.)	% on 100 MVA base	S, D, R
Series Reactance (+ve, -ve & zero seq.)	% on 100 MVA base	S, D, R
Shunt Susceptance (+ve, -ve & zero seq.)	% on 100 MVA base	S, D, R
Normal and short-time emergency ratings	MVA	S, D, R
Technical Details of *generating 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 *protection schemes* on *lines,* or cables	ohms or % on 100 MVA base	S, D
Number *of protection schemes* 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	S, D, R1
Location and Rating of individual *shunt capacitor* banks	MVAr	S, D, R1
Capacitor Bank capacitance	Microfarads	S, D
Inductance of switching reactor (if fitted)	millihenries	S, D
Resistance of capacitor plus reactor	Ohms	S, D
Details of special controls (e.g. Point-on-wave switching)	Text	S, 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 4 - METERING REQUIREMENTS

A4.1 General

(a) *Revenue metering* equipment, other than *revenue meters* and Communications equipment may be provided and installed by the *User* or will be provided and installed by the *Network Operator* at the *User's* request.

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

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

(d) *Revenue metering* equipment will comprise a *revenue 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 *revenue meters,* cabling, communications equipment, marshalling box and a *revenue meter* enclosure.

A4.2 Installation

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

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

(c) Prefabricated free standing or wall mounted *revenue meter* enclosures are available from the *Network Operator* or a suitable enclosure may be assembled by the *User. Revenue meters* may also be located within a building which has provision for unrestricted 24 hour access for *revenue metering* personnel. It may be located adjacent to the *Network Operator's 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 the *Network Operator* is requested to provide a free standing *revenue meter* enclosure and its support frame, the *User* will need to provide a concrete footing as specified in the *Network Operator's Metering Manuals.*

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

A4.3 3-4 Wire Metering

Three-wire *revenue metering,* that is, *revenue 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 *revenue 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 *revenue metering* CTs and VTs and the system *voltage* is less than 66kV. All other *revenue metering* will be four-wire, that is, as for three-wire but with an additional CT in the white phase. Co-generation *revenue metering* will normally be four-wire.

The *Network Operator* 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 30V AC or DC at a maximum of 60 mA. 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 *Revenue metering Installation*

Type	Energy (GWh pa.) per metering point	Maximum allowable overall error (+/- %) at full load active reactive	Minimum acceptable class of components	Meter clock error for CST seconds
1	greater than 1000	0.5 1.0	0.2 CT/VT/meter Wh 0.5 Meter VArh	+/- 5
2	100 – 1000	1.0 2.0	0.5 CT/VT/meter Wh 1.0 Meter VArh	+/-7
3	less than 100	1.5 3.0	0.5 CT/VT 1.0 Meter Wh 2.0 Meter VArh	+/-10

NOTE:

The method for calculating the overall error is the vector sum of the errors of each component part, ie a + 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 *revenue meter.*

A4.6 Other Metering Requirements

Specifications for *revenue meter* and communications enclosures, indoor and outdoor *revenue metering* units (VTs and CTs plus enclosure), 66kV and 132kV CTs, VTs, marshalling box and wiring are contained in the *Network Operator's Metering Manuals.*

ATTACHMENT 5 - 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) Galvanic isolation and filtering of input signals should be provided whenever necessary.

shall

A5.2 Test Preparation and Presentation of Test Results

Information/data prior to tests

(a) a detailed schedule of tests agreed by the *Network Operator.* 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 sub-networks 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 the *Network Operator* for the purpose of arranging witnessing of tests.

(b) The *Network Operator'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 shall be presented to the *Network Operator* 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.

A5.3 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

- stator L-N terminal *voltages*
- 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

Reciprocating Engine

- Engine crank speed driving the generator
- Type of governor load / speed control
- Ambient / charge air / exhaust temperature
- Fuel flow

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

(c) Key quantities such as stator terminal *voltages*, currents, *active power* and *reactive power* of the other *generating units* connected on the same bus and also interconnection lines with the *Network Operator's network* (from control room readings) before and after each test shall 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 at the following outputs • 50% rated MW • 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 test in (ii) • smaller step changes should precede larger step changes
C3	As for C2 but with the *power system 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 (U_t) (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 U_t between 0.5 – 0.9 pu • on 0.5 pu step for U_t 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 lead rejection

C6	Load rejection (*reactive power*)	(a) –30% rated MVAr (b) +25% rated MVAr	• nominal stator terminal volts • 0 or minimum MW output
C7	Load rejection (*reactive power*)	(a)–30% rated MVAr	• nominal stator terminal volts • Excitation Manual Control

ATTACHMENT 6 – ACCESS APPLICATION SCHEDULE

(a) A person who is not an existing *user* and who wants the *Network Operator* to provide it with one or more *access services* shall make an *access application* in accordance with this schedule.

(b) A person who is an existing *user* and who wants the *Network Operator* to provide it with one or more *access services* (including additional capacity) in addition to those which the *user* has access already shall make an *access application* in accordance with this schedule.

(c) An *access application* may only be make for the provision of *access services* which the applicant wishes the *Network Operator* to commence to provide within 3 years of the date of the access application.

(d) An *access application* shall contain the following information:

(1) the name and address of the person making the *access application* and of any other persons for whom that person is acting in making the *access application*;

(2) the type of *access services* requested, when those *access services* are required and for how long they will be required;

(3) the entry points and exit points in respect of which access is being applied for and the capacity (expressed in MW) for each of those entry points and exit points for which access is being applied for;

(4) the type of *plant* in respect of which the *access services* are required and the configuration of that *plant*;

(5) where the entry points and exit points are to be on the *electrical network* and any alternative points (in order of preference);

(6) the expected maximum demand of the *plant* connected or to be connected at each of the entry points;

(7) the maximum generation capacity and the proposed declared sent out capacity of the *generating units* (including *embedded generation* units) connected or to be connected at each of the exit points;

(8) the expected electricity production and consumption of the *plant connected* or to be *connected* at each of the entry points and exit points;

(9) when the applicant expects the *plant* to be *connected* at each of the entry points and exit points to be in service (if appropriate);

(10) details of the *controllers* of the *plant connected* or to be *connected* at each of the entry points and exit points;

(11) the proposed design of each of the *connections* (if appropriate);

(12) the arrangements which the applicant proposes to enter into in relation to the construction and supply of the *connection* in respect of the *plant*;

(13) the nature of any disturbing *load* (size of disturbing component MW/MVAr, duty cycle, nature of power electronic *plant* which may produce harmonic distortion);

(14) any information as required by this *Code*;

(15) commercial information concerning the applicant to allow the *Network Operator* to make an assessment of the ability of the applicant to meet its obligations under any *access agreement* that results from the *access application*; and

(16) any other information reasonably required by the *Network Operator*;

and may specify that the applicant wishes the *Network Operator* to make a preliminary assessment of the application.

(e) The *Network Operator* shall give the applicant a written response within 20 *business days* after receiving the *access application*.

(f) A response in respect of an *access application* shall include the following information:

(1) whether it is likely that there is sufficient *spare capacity* to provide the *access services* requested in the *access application* or whether the *electricity network* will have to be *augmented* to provide those services;

(2) whether it is likely that any *connection* will have to be installed or upgraded to provide the *connection services* (if any) requested in the *access application*;

(3) if the *Network Operator* believes that the *electricity network* will have to be *augmented* to provide that *access services* requested or a new connection will have to be installed or an existing connection augmented to provide the *connection services* (if any) requested, then whether or not a capital contribution will be required of the *user* and if so, an indication of the likely amount of that capital contribution;

(4) the period within which the *Network Operator* is able to make a preliminary assessment of the *access application*; and

(5) whether the *Network Operator* is able to make an access offer to the applicant within 65 *business days* of receiving the *access application*, and if not, an alternative period that is reasonable for making the access offer.

(g) The information provided under clauses (f)(1), (f)(2) and (f)(3) above is indicative and is not binding on the *Network Operator*.