IMPORTANT NOTE: This document is subject to amendment (amendments must be made in accordance with the *Electricity Networks Access Code 2004*). The latest version of this document can be obtained from Western Power and is available for downloading from, Western Power's internet site: [http://www.westernpower.com.au](http://www.westernpower.com.au)
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PREFACE

The Electricity Networks Corporation, trading as Western Power, was established on 1 April 2006 by the Electricity Corporations Act (2005) (WA).

Western Power is required to provide open access to capacity in its electricity *transmission and distribution systems*. The principal objective of open access is to facilitate competition in the energy industry by allowing independent *Generators* to *supply associated loads* by utilising Western Power's networks. The Electricity Networks Access Code 2004 (WA) (the "Access Code"), which superseded the initial regulations, covers *transmission and distribution systems*. Chapter 12 of the Access Code requires Western Power to publish Technical Rules (the "Rules"). In addition, section A6.1(m) requires Western Power to publish *transmission system planning criteria*.

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

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

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(08) 9326 4556

Faesimile: (08) 9326 4595

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

It is important to note that amendments to this document, and variations and exemptions to Rules requirements granted to Users, can only be made in accordance with the Access Code.
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# TECHNICAL RULES FOR THE SOUTH WEST INTERCONNECTED NETWORK

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1. **GENERAL**

1.1 **INTRODUCTION**

(a) This section 1 defines the scope of the Rules both as to their content and their application. It provides rules of interpretation and refers to the dispute resolution process. It establishes the obligations of all parties and defines the methodology for variations, exemptions and amendments to these Rules.

(b) The objectives of these Rules are that they:

(1) are reasonable;

(2) do not impose inappropriate barriers to entry to a market;

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

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

1.2 **AUTHORISATION**

These Rules are made under chapter 12 of the Access Code. They set out:

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

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

(c) the requirements for the operation of the transmission and distribution systems (including the operation of the transmission and distribution systems in emergency situations or where there is a possibility of a person suffering injury but excluding the operation of those parts of the transmission system under the control of System Management acting in accordance with the Market Rules);

(d) the obligations of Users to test equipment in order to demonstrate compliance with the technical requirements referred to in clause 1.2(b) and the operational requirements referred to in clause 1.2(c);

(e) the procedures which apply if the Network Service Provider believes that a User's equipment does not comply with the requirements of these Rules;

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

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

(h) the requirements for control and protection settings for equipment connected to the transmission and distribution systems;
(i) the procedures for the commissioning and testing of new *equipment connected* to the *transmission and distribution systems*;

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

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

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

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

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

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

1.3 **APPLICATION**

(a) In these *Rules*, unless otherwise stated, a reference to the *Network Service Provider* refers to the *service provider* for the *South West Interconnected Network*. The *service provider* for the *South West Interconnected Network*, is the Electricity Networks Corporation, a statutory corporation established by the Electricity Corporations Act (2005) (WA) but, for the purpose of these *Rules* does not include *System Management*.

(b) These *Rules* apply to:

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

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

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

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

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

1.4 COMMENCEMENT

These Rules come into operation on 1 July 2007 (the "Rules commencement date"). Where the Rules have been amended or revised, the commencement date of each Revision is the date on the cover page unless otherwise indicated.

1.5 INTERPRETATION

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

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

1.6 THE NETWORK SERVICE PROVIDER AND USERS TO ACT REASONABLY

1.6.1 Importance of objectives

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

1.6.2 Acting reasonably

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

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

1.7 DISPUTE RESOLUTION

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

1.8 OBLIGATIONS

1.8.1 General

(a) Users and the Network Service Provider must maintain and operate (or ensure their authorised representatives maintain and operate) all equipment that is part of their respective facilities in accordance with:
(1) relevant laws;
(2) the requirements of the Access Code;
(3) the requirements of these Rules; and
(4) good electricity industry practice and applicable Australian Standards.

(b) Where an obligation is imposed under these Rules to arrange or control any act, matter or thing or to ensure that any other person undertakes or refrains from any act, that obligation is limited to a requirement to use all reasonable endeavours in accordance with the Access Code, to comply with that obligation.

(c) If the Network Service Provider, System Management or a User fails to arrange or control any act, matter or thing or the acts of any other person, the Network Service Provider, System Management or User is not taken to have breached such obligation imposed under these Rules provided the Network Service Provider, System Management or User used all reasonable endeavours to comply with that obligation.

1.8.2 Obligations of the Network Service Provider

(a) The Network Service Provider must comply with the performance standards described in these Rules.

(b) The Network Service Provider must:

(1) ensure that, for connection points on the transmission and distribution systems, every arrangement for connection with a User complies with all relevant provisions of these Rules;
(2) permit and participate in inspection and testing of facilities and equipment in accordance with clause 4.1;
(3) permit and participate in commissioning of facilities and equipment which is to be connected to the transmission system in accordance with clause 4.2;
(4) advise a User with whom there is an access contract of any expected interruption or reduced level of service at a connection point so that the User may make alternative arrangements for supply during such interruptions; and
(5) ensure that modelling data used for planning, design and operational purposes is complete and accurate and undertake tests, or require Users to undertake tests in accordance with clause 4.1, where there are grounds to question the validity of data.

(c) The Network Service Provider must arrange for:
(1) management, maintenance and operation of the transmission and distribution systems such that when the power system is in the normal operating state electricity may be transferred continuously at a connection point up to the agreed capability of that connection point;

(2) management, maintenance and operation of the transmission and distribution systems to minimise the number and impact of interruptions or service level reductions to Users; and

(3) restoration of the agreed capability of a connection point as soon as reasonably practicable following any interruption or reduction in service level at that connection point.

1.9 VARIATIONS AND EXEMPTIONS FROM THE RULES

1.9.1 User Exemptions from these Rules

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

(b) Where an exemption granted under these Rules may impact the operation or security of the power system, the Network Service Provider must consult with the Independent Market Operator and/or System Management as appropriate before deciding whether to grant the exemption.

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

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

1.9.2 Network Service Provider Exemptions from these Rules

Exemptions from one or more requirements of these Rules may be granted to the Network Service Provider and all applicants, Users and controllers of the transmission and distribution systems by the Authority as set out in sections 12.40 to 12.49 of the Access Code.

1.9.3 Amendment to the Rules

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

(b) Where a User can demonstrate that an International or Australian Standard, which is not specified in these Rules, has equal or more onerous requirements to a specified Standard, the Network Service Provider must submit a proposal to the Authority, in accordance with the requirements of section 12.50 of the Access Code, to amend the Rules to include the proposed Standard. The submission must be supported by a report from a competent body, approved by the
Australian National Association of Test Laboratories (NATA), which confirms that the requirements of the proposed International or Australian Standards are equal or more onerous to those of the specified Standard.

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

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

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

1.9.5 **Ongoing Suitability**

A User or the Network Service Provider whose equipment is deemed by clause 1.9.4 to comply with the requirements of these Rules must ensure that the capabilities and ratings of that equipment are monitored on an ongoing basis and must ensure its continued safety and suitability as conditions on the power system change.
2. **TRANSMISSION AND DISTRIBUTION SYSTEM PERFORMANCE AND PLANNING CRITERIA**

2.1 **INTRODUCTION**

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

2.2 **POWER SYSTEM PERFORMANCE STANDARDS**

2.2.1 **Frequency Variations**

(a) The nominal operating frequency of the power system is 50 Hz.

(b) The accumulated synchronous time error must be less than 10 seconds for 99% of the time.

(c) The frequency operating standards for the power system are summarised in Table 2.1.
Table 2.1 *Frequency operating standards for the South West Interconnected Network.*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Frequency Band</th>
<th>Target Recovery Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Range:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South West</td>
<td>49.8 to 50.2 Hz for 99% of the time</td>
<td>Normal Range: within 15 minutes. For over-frequency events: below 50.5 Hz within 2 minutes.</td>
</tr>
<tr>
<td>Island(1)</td>
<td>49.5 to 50.5 Hz</td>
<td>Normal Range: within 15 minutes. For over-frequency events: below 50.5 Hz within 2 minutes.</td>
</tr>
<tr>
<td>Single contingency event</td>
<td>48.75 to 51 Hz</td>
<td>Normal Range: within 15 minutes. For over-frequency events: below 50.5 Hz within 2 minutes.</td>
</tr>
<tr>
<td>Multiple contingency event</td>
<td>47.0 to 52.0 Hz</td>
<td>Normal Range: within 15 minutes. For under-frequency events:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(a) above 47.5 Hz within 10 seconds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) above 48.0 Hz within 5 minutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) above 48.5 Hz within 15 minutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) For over-frequency events:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(e) below 51.5 Hz within 1 minute</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(f) below 51.0 Hz within 2 minutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(g) below 50.5 Hz within 5 minutes</td>
</tr>
</tbody>
</table>

Note: An island is formed when the interconnection between parts of the interconnected transmission system is broken, for example if the interconnection between the Goldfields region and remainder of the power system is broken.
(d) The *frequency operating standards* must be satisfied, provided that there is no shortage of *spinning reserve* in accordance with clause 3.10.2 of the *Market Rules*, without the use of *load shedding* under all credible power system load and generation patterns and the most severe credible contingency event.

(e) In the event of a loss of interconnecting *equipment* leading to the formation of an island separate from the rest of the *power system*, *load shedding facilities* within the island may be used to ensure that the *frequency operating standards* specified in Table 2.1 are satisfied within the islanded part of the *power system*. Once the *power system* within the island has returned to a steady state operating condition, the “island” *frequency range* in Table 2.1 will apply until the islanded *power system* is resynchronised to the main *power system*.

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

### 2.2.2 Steady State Power Frequency Voltage

(a) Except as a consequence of a non-credible *contingency event*, the minimum steady state *voltage* on the *transmission system* and those parts of the *distribution system* operating at *voltages* of 6 kV and above must be 90% of nominal *voltage* and the maximum steady state *voltage* must be 110% of nominal *voltage*. For those parts of the *distribution system* operating below *voltages* of 6 kV, the steady state *voltage* must be within:

1. **± 6% of the nominal voltage** during normal operating state,
2. **± 8% of the nominal voltage** during maintenance conditions,
3. **±10% of the nominal voltage** during emergency conditions.

(b) Step *changes* in steady state *voltage* levels resulting from switching operations must not exceed the limits given in Table 2.2.
### Table 2.2 Step-change voltage limits

<table>
<thead>
<tr>
<th>Cause</th>
<th>Pre-switching (quasi steady-state) and during tap-changing</th>
<th>Post-switching (final steady state)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Transmission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Distribution</td>
</tr>
<tr>
<td>Routine Switching$^{(1)}$</td>
<td>$r$ (hour$^{-1}$)</td>
<td>$U_{dyn}^{(3)}/U_N^{(4)}$ (%)</td>
</tr>
<tr>
<td></td>
<td>$r \leq 1$</td>
<td>$\pm 4.0%$</td>
</tr>
<tr>
<td></td>
<td>$1 &lt; r \leq 10$</td>
<td>$\pm 3.0%$</td>
</tr>
<tr>
<td></td>
<td>$10 &lt; r \leq 100$</td>
<td>$\pm 2.0%$</td>
</tr>
<tr>
<td></td>
<td>$100 &lt; r \leq 1000$</td>
<td>$\pm 1.25%$</td>
</tr>
<tr>
<td>Infrequent Switching$^{(2)}$</td>
<td></td>
<td>+6%, $-10%$</td>
</tr>
</tbody>
</table>

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

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

2.2.3 Flicker

(a) Rapid voltage fluctuations cause changes to the luminance of lamps which can create the visual phenomenon called flicker. Flicker severity is characterised by the following two quantities, which are defined in AS/NZS 61000.3.7 (2001):

(1) \( P_{st} \) - short-term flicker severity term (obtained for each 10 minute period);

(2) \( P_{lt} \) - long-term flicker severity (obtained for each 2 hour period).

(b) Under normal operating conditions, flicker severity caused by voltage fluctuation in the transmission and distribution system must be within the planning levels shown in Table 2.3 for 99% of the time.

Table 2.3 Planning levels for flicker severity

<table>
<thead>
<tr>
<th>Flicker Severity Quantity</th>
<th>LV (415 V)</th>
<th>MV (≤ 35 kV)</th>
<th>HV-EHV (&gt; 35 kV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( P_{st} )</td>
<td>1.0</td>
<td>0.9</td>
<td>0.8</td>
</tr>
<tr>
<td>( P_{lt} )</td>
<td>0.65</td>
<td>0.7</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Notes:
1. These values were chosen on the assumption that the transfer coefficients between MV or HV systems and LV systems are unity. The planning levels could be increased in accordance with AS61000.3.7 (2001).
2. The planning levels in Table 2.3 are not intended to apply to flicker arising from contingency and other uncontrollable events in the power system, etc.

2.2.4 Harmonics

Under normal operating conditions, the harmonic voltage in the transmission and distribution systems must not exceed the planning levels shown in Table 2.4 and Table 2.5 (as applicable) appropriate to the voltage level, whereas the interharmonics voltage must not exceed the planning levels of AS/NZS 61000.3.6 (2001).
Table 2.4 *Distribution* planning levels for harmonic *voltage* in networks with system *voltage* less than or equal to 35 kV (in percent of the nominal *voltage*)

<table>
<thead>
<tr>
<th>Odd harmonics non multiple of 3</th>
<th>Odd harmonics multiple of 3</th>
<th>Even harmonics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Order h</strong></td>
<td><strong>Harmonic voltage %</strong></td>
<td><strong>Order h</strong></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>13</td>
<td>2.5</td>
<td>21</td>
</tr>
<tr>
<td>17</td>
<td>1.6</td>
<td>&gt;21</td>
</tr>
<tr>
<td>19</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>&gt;25</td>
<td>0.2 + $0.5 \frac{25}{h}$</td>
<td></td>
</tr>
</tbody>
</table>

Total harmonic distortion (THD): 6.5 %
Table 2.5 *Transmission* planning levels for harmonic *voltage* in networks with system *voltage* above 35 kV (in percent of the nominal *voltage*)

<table>
<thead>
<tr>
<th>Odd harmonics non multiple of 3</th>
<th>Odd harmonics multiple of 3</th>
<th>Even harmonics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Order h</strong></td>
<td><strong>Harmonic voltage %</strong></td>
<td><strong>Order h</strong></td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>11</td>
<td>1.5</td>
<td>15</td>
</tr>
<tr>
<td>13</td>
<td>1.5</td>
<td>21</td>
</tr>
<tr>
<td>17</td>
<td>1</td>
<td>&gt;21</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>&gt;25</td>
<td>0.2 + 0.5(\frac{25}{h})</td>
<td></td>
</tr>
</tbody>
</table>

Total harmonic distortion (THD): 3 %

**Notes:**
1. The planning levels in *Table 2.4* and *Table 2.5* are not intended to apply to harmonics arising from *uncontrollable* events such as geomagnetic storms, etc.
2. The total harmonic distortion (THD) is calculated from the formula:

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

where:
- \(U_{nom}\) = nominal *voltage* of a system;
- \(U_1\) = fundamental *voltage*;
- \(U_h\) = harmonic *voltage* of order \(h\) expressed in percent of the nominal *voltage*.
3. *Table 2.4* and *Table 2.5* are consistent with *AS 61000* (2001).
2.2.5 Negative Phase Sequence Voltage

The 10 minute average level of negative phase sequence voltage at all connection points must be equal to or less than the values set out in Table 2.6.

Table 2.6 Limits for negative phase sequence component of voltage (in percent of the positive phase sequence component)

<table>
<thead>
<tr>
<th>Nominal System Voltage (kV)</th>
<th>Negative Sequence Voltage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 100</td>
<td>1</td>
</tr>
<tr>
<td>10 – 100</td>
<td>1.5</td>
</tr>
<tr>
<td>&lt; 10</td>
<td>2</td>
</tr>
</tbody>
</table>

2.2.6 Electromagnetic Interference

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

2.2.7 Transient Rotor Angle Stability

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

2.2.8 Oscillatory Rotor Angle Stability

System oscillations originating from system electro-mechanical characteristics, electromagnetic effect or non-linearity of system components, and triggered by any small disturbance or large disturbance in the power system, must remain within the small disturbance rotor angle stability criteria and the power system must return to a stable operating state following the disturbance. The small disturbance rotor angle stability criteria are:

(a) The damping ratio of electromechanical oscillations must be at least 0.1.

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

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

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

(b) Stable voltage control must be maintained following the most severe credible contingency event.

2.2.10 Temporary Over-Voltages

As a consequence of a credible contingency event, the power frequency voltage at all locations in the power system must remain within the over-voltage envelope shown in Figure 2.1.

![Figure 2.1 - Highest acceptable level and duration of AC temporary overvoltage](image)

**Note:** In Figure 2.1 the percentage voltage level refers to either the nominal voltage or the mid point of the target voltage range for a connection point, where such a range has been set in accordance with clause 2.2.2(c). For the purposes of this clause the voltage is the RMS phase to phase voltage.

2.2.11 Long Term Voltage Stability

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

(b) The long term voltage stability criterion is that the voltage at all locations in the power system must be stable and controllable following the most onerous post-contingent system state following the occurrence of any credible contingency event under all credible load conditions and generation patterns.
2.3 OBLIGATIONS OF NETWORK SERVICE PROVIDER IN RELATION TO POWER SYSTEM PERFORMANCE

2.3.1 Frequency Control

(a) The Network Service Provider must design and install an automatic underfrequency load shedding system on the transmission and distribution systems to ensure that the frequency performance of the power system following a multiple contingency event, as specified in Table 2.1, can be achieved. Further information on the technical requirements of this system is given in clause 2.4.

(b) The automatic underfrequency load shedding system must be designed to ensure that, should a contingency event occur that results in the formation of islands, each island in the power system that contains generation has sufficient load shedding facilities to aid recovery of the frequency to the normal band within the time frames specified in Table 2.1.

(c) The Network Service Provider may require commercial and industrial Consumers to make a portion of their load available for automatic underfrequency or undervoltage load shedding or both and may also require a commercial or industrial Consumer to provide control and monitoring equipment for the load shedding facilities. The amount of load to be available for shedding and the frequencies or voltages or both at which load must be shed must be negotiated between the Network Service Provider and the User or, failing agreement between them, must be as specified by the Network Services Provider consistent with Table 2.8, and must be specified in the relevant connection agreement.

2.3.2 Load to be Available for Disconnection

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

   (1) the automatic control of underfrequency relays;

   (2) manual or automatic control from control centres; and

   (3) the automatic control of undervoltage relays.

(b) To satisfy this overall criterion, the Network Service Provider may, at its discretion, arrange for up to 90% of the power system load if necessary to ensure that the frequency performance standard specified in clause 2.2.1 can be met for all credible power system load and generation patterns, to be available for automatic disconnection. The Network Service Provider must advise Users if this additional requirement is necessary.

(c) The Network Service Provider may install special load shedding arrangements to cater for abnormal operating conditions.
(d) Arrangements for load shedding must include the opening of circuits in the distribution system and may include the opening of circuits in the transmission system.

(e) The Network Service Provider must use its best endeavours to assign feeders to stages within the load shedding system so that loads supplying essential services are not made available for shedding or are given a lower load shedding priority than other load.

2.3.3 Flicker

(a) To ensure that the flicker level at any point of common coupling on the transmission or distribution system does not exceed the maximum levels specified in clause 2.2.3, the Network Service Provider must, where necessary and after consultation with the relevant Users, allocate flicker emission limits to Users in accordance with clauses 2.3.3(b) and 2.3.3(c).

(b) The Network Service Provider must allocate contributions to limits no more onerous than the lesser of the acceptance levels determined in accordance with the stage 1 and the stage 2 evaluation procedures defined in AS/ANZ 61000.3.7 (2001).

(c) If the User cannot meet the contribution calculated by using the method of clause 2.2.3(b), then the Network Service Provider may use, in consultation with the party seeking connection, the stage 3 evaluation procedure defined in AS/ANZ 61000.3.7 (2001).

(d) The Network Service Provider must verify compliance of Users with allocated flicker emission levels. The contribution may be assessed by direct measurement or by calculation from the available data for the load and the power system. In verifying compliance, measurements of flicker must be carried out according to AS/NZS 61000 (2001).

2.3.4 Harmonics

(a) To ensure that the harmonic or interharmonic level at any point of common coupling on the transmission or distribution system does not exceed the maximum levels specified in clause 2.2.4, the Network Service Provider must, where necessary and after consultation with the relevant Users, allocate harmonic emission limits to Users in accordance with AS/NZS 61000.3.6 (2001).

(b) The Network Service Provider must verify compliance of Users with allocated harmonic or interharmonic emission levels. The contribution may be assessed by direct measurement or by calculation from the available data for the load and the power system.

(c) The measurement must be carried out according to AS/NZS 61000.4.7 (1999). Harmonics must generally be measured up to h=40. However, higher order harmonics up to 100th order may be measured if the Network Service Provider
reasonably considers them to be of material concern.

2.3.5 **Negative Phase Sequence Voltage**

(a) If the maximum level of negative phase sequence voltage, as specified in Table 2.6, is exceeded at any connection point on the transmission or distribution system, the Network Service Provider must remedy the problem to the extent that it is caused by the transmission and distribution systems.

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

2.3.6 **Electromagnetic Interference**

The Network Service Provider must respond to all complaints regarding electromagnetic interference in a timely manner and undertake any necessary tests to determine whether or not the interference is caused by equipment forming part of the transmission and distribution systems, and whether or not it exceeds the limits specified in clause 2.2.6. If the complaint is justified, the Network Service Provider must, as soon as reasonably practicable, take any necessary action to reduce the interference to below the maximum prescribed levels.

2.3.7 **Power System Stability and Dynamic Performance**

2.3.7.1 **Short Term Stability**

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

(b) To ensure compliance with clause 2.3.7.1(a), the Network Service Provider must simulate the short term dynamic performance of the power system. Dynamic models of individual components must be verified and documented.

(c) In planning the transmission and distribution system, the Network Service Provider must:

1. assume a transmission and distribution system operating configuration with equipment out of service for maintenance where this is provided for in the planning criteria specified in clause 2.5; and

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

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

2.3.7.2 Short Term Voltage Stability

(a) The assessment of the compliance of the transmission and distribution systems with the different short term voltage stability criteria specified in clause 2.2 must be made using simulation of the system response with the best available models of voltage-dependent loads (including representative separate models of motor loads where appropriate).

(b) The assessment must be made using simulation of the system response with the short-term overload capability of the voltage/excitation control system capability of each generating unit or other reactive source represented (magnitude and duration). This is to include representation of the operation and settings of any limiters or other controls that may impact on the performance of reactive power sources.

2.3.7.3 Long Term Voltage Stability

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

(b) The long term voltage stability analysis must then be carried out by a series of load-flow simulations of the transmission system and, where necessary, the distribution system or by using dedicated long-term dynamics software to ensure that adequate reactive power reserves are provided within the transmission and distribution systems to meet the long term voltage stability criteria in clause 2.2.11, for all credible generation patterns and system conditions.

(c) The Network Service Provider must model the power system for long term stability assessment and transfer limit determination purposes, pursuant to clause 2.3.7.3(b) using the following procedure:

(1) for terminal substations in the Perth metropolitan area, 3% of the total installed capacitor banks plus the reactive device that has the largest impact on the power system must be assumed to be out of service; and

(2) for other areas of the power system, including radials:
(A) the normal peak power system generation pattern, or other credible generation pattern determined by operational experience to be more critical, that provides the lowest level of voltage support to the area of interest must be assumed. Of the generating units normally in service in the area, the generating unit that has the largest impact on that area must be assumed to be out-of-service due to a breakdown or other maintenance requirements. If another generating unit is assigned as a back-up, that generating unit may be assumed to be brought into service to support the load area; and

(B) the largest capacitor bank, or the reactive device that has the largest impact in the area, must be assumed to be out-of-service, where the area involves more than one substation.

(3) In all situations the Network Service Provider must follow the following additional modelling procedures:

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

(B) the load or power transfer to be used in the study must be assumed to be 5% higher than the expected system peak load, or 5% higher than the maximum expected power transfer into the area. (The 5% margin includes a safety margin for hot weather, data uncertainty and uncertainty in the simulation). The power system voltages must remain within normal limits with this high load or power transfer;

(C) the analysis must demonstrate that a positive reactive power reserve margin is maintained at major load points, and that power system voltages remain within the normal operating range for this 5% higher load; and

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

2.3.7.4 Validation of Modelling Results

The Network Service Provider must take all reasonable steps to ensure that the results of the simulation and modelling of the power system in accordance with the requirements of clauses 2.3.7.1 to 2.3.7.3 and section 3 are valid. This may include power system and plant performance tests in accordance with clause 4.1.

2.3.8 Determination of Power Transfer Limits

(a) The Network Service Provider must assign, on a request by a User or System Management, power transfer limits to equipment forming part of the
transmission and distribution systems. The assigned power transfer limits must ensure that the system performance criteria specified in clause 2.2 are met and may be lower than the equipment thermal ratings. Further, the assigned power transfer limits may vary in accordance with different power system operating conditions and, consistent with the requirements of these Rules, should to the extent practicable maximise the power transfer capacity made available to Users.

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

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

2.3.9 Assessment of Power System Performance

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

(b) The Network Service Provider must ensure that system performance parameter measurements to ensure that the power system complies with the performance standards specified in clauses 2.2.1 to 2.2.5 are taken as specified in Table 2.7. Records of all test results must be retained by the Network Service Provider and made available to the Authority, System Management or the Independent Market Operator on request.
Table 2.7 Power quality parameters measurement

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value measured</th>
<th>Frequency of measurement</th>
<th>Minimum measurement period</th>
<th>Data sampling interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundamental Frequency</td>
<td>mean value over interval</td>
<td>Continuous</td>
<td>all the time</td>
<td>10 seconds</td>
</tr>
<tr>
<td>Power-frequency voltage magnitude</td>
<td>mean rms value over interval</td>
<td>In response to a complaint, or otherwise as required by the Network Service Provider.</td>
<td>one week</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Short-term flicker severity</td>
<td>$P_{st}$</td>
<td>In response to a complaint, or otherwise as required by the Network Service Provider.</td>
<td>one week</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Long-term flicker severity</td>
<td>$P_{lt}$</td>
<td>In response to a complaint, or otherwise as required by the Network Service Provider.</td>
<td>one week</td>
<td>2 hours</td>
</tr>
<tr>
<td>Harmonic / interharmonic voltage and voltage THD</td>
<td>mean rms value over interval</td>
<td>In response to a complaint, or otherwise as required by the Network Service Provider.</td>
<td>one week</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Negative sequence voltage</td>
<td>mean rms value over interval</td>
<td>In response to a complaint, or otherwise as required by the Network Service Provider.</td>
<td>one week</td>
<td>10 minutes</td>
</tr>
</tbody>
</table>

Notes:
1. The power quality parameters, except fundamental frequency and negative sequence voltage, must be measured in each phase of a three-phase system.
2. The fundamental frequency must be measured based on line-to-neutral voltage in one of the phases or line-to-line voltage between two phases.
3. Other parameters and data sampling intervals may be used to assess the Network Service Provider's transmission and distribution system and User system performance during specific events.
2.4 **LOAD SHEDDING FACILITIES**

2.4.1 **Settings of Under-Frequency Load shedding Schemes**

(a) The settings for the under-frequency load shedding (UFLS) scheme are stated in Table 2.8.

(b) Switchable capacitor banks at substations must be shed in accordance with Table 2.8.

Table 2.8 Under-frequency load shedding scheme settings for the South West Interconnected Network

<table>
<thead>
<tr>
<th>Stage</th>
<th>Frequency (Hz)</th>
<th>Time Delay (sec)</th>
<th>Load Shed (%)</th>
<th>Cumulative Load Shed (%)</th>
<th>Capacitor shed (%)</th>
<th>Cumulative Capacitor Shed (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>48.75</td>
<td>0.4</td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>48.50</td>
<td>0.4</td>
<td>15</td>
<td>30</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>48.25</td>
<td>0.4</td>
<td>15</td>
<td>45</td>
<td>20</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>48.00</td>
<td>0.4</td>
<td>15</td>
<td>60</td>
<td>25</td>
<td>70</td>
</tr>
<tr>
<td>5</td>
<td>47.75</td>
<td>0.4</td>
<td>15</td>
<td>75</td>
<td>30</td>
<td>100</td>
</tr>
</tbody>
</table>

2.5 **TRANSMISSION AND DISTRIBUTION SYSTEM PLANNING CRITERIA**

2.5.1 **Application**

The planning criteria in this clause 2.5 apply only to the transmission and distribution systems and not to connection assets. The Network Service Provider must design connection assets in accordance with a User's requirements and the relevant requirements of section 3.

2.5.2 **Transmission system**

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

2.5.2.1 **N-0 Criterion**

(a) A sub-network of the transmission system designed to the N-0 criterion will experience the loss of the ability to transfer power into the area supplied by that sub-network on the loss of a transmission element. Following such an event this power transfer capability will not be restored until the transmission element has been repaired or replaced.

(b) The N-0 criterion may be applied to sub-networks with a peak load of less than 20 MVA and to zone substations with a peak load of less than 10 MVA. The
N-0 criterion also applies to the 220 kV interconnection supplying the Eastern Goldfields region.

In the event of an unplanned outage of the 220 kV interconnection supplying the Eastern Goldfields region the power system is expected to split into two islands. Arrangements are in place to supply the Kalgoorlie-Boulder city and Coolgardie town loads during an interconnection outage but Users outside these areas will need to make their own arrangements for any back-up generation requirement.

(c) For a sub-network designed to the N-0 planning criteria, the Network Service Provider must use its best endeavours to transfer load to other parts of the transmission or distribution system to the extent that this is possible and that spare power transfer capacity is available. If insufficient back-up power transfer capacity is available, load shedding is permissible. Where a supply loss is of long duration, the Network Service Provider must endeavour to ration access to any available power transfer capacity by rotating the load shedding amongst the Consumers affected.

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

2.5.2.2 N-1 Criterion

(a) Any sub-network of the transmission system that is not identified within this clause 2.5.2 as being designed to another criterion must be designed to the N-1 planning criterion.

(b) For sub-networks designed to the N-1 criterion (excluding a zone substation designed to the 1% risk or NCR criteria in accordance with clause 2.5.4), supply must be maintained and load shedding avoided at any load level and for any generation schedule following an outage of any single transmission element.

(c) Following the loss of the transmission element, the power system must continue to operate in accordance with the power system performance standards specified in clause 2.2.

(d) Notwithstanding the requirements clauses 2.5.2.2(b) and 2.5.2.2(c), where the failed transmission element is a zone substation supply transformer, supply may be lost for a brief switching period while loads are transferred to un-faulted supply transformers by means of distribution system switching. The Network Service Provider must maintain sufficient power transfer capacity to allow supply to all Consumers to be restored following switching.

2.5.2.3 N-1-1 Criterion

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

1. all 330 kV lines, substations and power stations;
2. all 132 kV terminal stations in the Perth metropolitan area, and Muja power station 132 kV substation;
3. all 132 kV transmission lines that supply a sub-system of the transmission system comprising more than 5 zone substations with total peak load exceeding 400 MVA; and
4. all power stations whose total rated export to the transmission system exceeds 600 MW.

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

**Table 2.9 Transmission system operating conditions allowed for by the N-1-1 criterion**

<table>
<thead>
<tr>
<th>Maintenance Outages and Contingencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>transmission line maintenance and unplanned transmission line outage</td>
</tr>
<tr>
<td>transformer maintenance and unplanned transformer outage</td>
</tr>
<tr>
<td>transformer maintenance and unplanned transmission line outage</td>
</tr>
<tr>
<td>busbar maintenance and unplanned transmission line outage</td>
</tr>
<tr>
<td>busbar maintenance and unplanned transformer outage</td>
</tr>
<tr>
<td>circuit breaker maintenance and unplanned transmission line outage</td>
</tr>
<tr>
<td>circuit breaker maintenance and unplanned transformer outage</td>
</tr>
<tr>
<td>circuit breaker maintenance and unplanned busbar outage</td>
</tr>
<tr>
<td>transmission line maintenance and unplanned transformer outage</td>
</tr>
</tbody>
</table>

(c) Under the N-1-1 criterion, each sub-network must be capable of withstanding the coincident planned and unplanned outages of transmission elements listed in Table 2.9 at up to 80% of the expected transmission system peak load. In determining whether the N-1-1 criteria have been met, the Network Service Provider may assume that, during the planned outage, generation has been rescheduled to mitigate the effect of the subsequent unplanned outage.

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

2.5.2.4  Circuit Breaker Failure

If a circuit breaker failure occurs and, as a result, a single phase to earth fault within a transmission system sub-network designed to the N-1-1 criterion is not cleared by a main protection scheme, the power system must return to a state that meets the steady state performance standards specified in clause 2.2.2 without generation rescheduling, provided that the power transfer at the time of the fault is no greater than 80% of the expected transmission system peak load and that, prior to the event, all transmission system equipment is in service.

2.5.3  Perth CBD Criterion

(a) The Perth CBD criterion applies to those sub-networks of the transmission system that transfer power to the Perth CBD and zone substations and the transmission lines that terminate in those zone substations that supply Perth CBD.

(b) Following any outage within a sub-network to which the Perth CBD criterion applies involving:

(1) one or two transmission lines;

(2) one or two supply transformers; or

(3) one transmission line and one supply transformer,

and irrespective of whether any single transmission element outage is planned or unplanned, there must be sufficient power transfer capacity in the transmission system to maintain supply to all Consumers within the Perth CBD without the need to reschedule generation.

(c) For an unplanned outage of a single supply transformer, there may be a supply interruption to some Consumers of up to 30 seconds to allow for the automatic transfer of the affected loads to other supply transformers within the same substation or to other substations using capacity that is kept available for this purpose.

(d) For unplanned outages of two transmission elements in accordance with clause 2.5.3(b), there may be a supply interruption to some Consumers of up to 2 hours to allow for the transfer of the affected loads to other supply transformers within the same substation or to other substations using capacity that is kept available for this purpose.

(e) Apart from the supply interruptions provided for in clauses 2.5.3(c) and 2.5.3(d), the power system must continue to meet the performance standards specified in clause 2.2.
2.5.4 Zone Substations

(a) The 1% Risk Criterion

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

(b) Normal Cyclic Rating (NCR) Criterion

(1) The NCR risk criterion permits the loss of a portion of power transfer capacity at a substation following the unplanned loss of a supply transformer within that substation.

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

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

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

Relationship between 1% Risk criterion and NCR criterion is explained below:

1. Zone substations require special consideration as they form the boundary between the transmission system and the distribution system. The 1% Risk Criterion and NCR Criterion permit higher supply transformer utilisation than that permitted by the N-1 criterion, but lower than that permitted by the N-0 criterion.

2. The 1% Risk and NCR criteria are based on sharing a common spare supply transformer among a population of supply transformers across a number of zone substations within a geographically confined area. A trade off is the risk of limited load shedding for as long as it takes to deploy and install a spare supply transformer. The acceptance of this risk determines the application of these two criteria.

2.5.4.1 Application of 1% Risk criterion

(a) The Network Service Provider may apply the 1% Risk criterion to major regional zone substations outside the Perth metropolitan area.

(b) No zone substation may be classified a 1% Risk substation unless a suitable system spare transformer is available to replace the failed transformer within a target period of 10 days.

(c) Following the loss of a supply transformer from a 1% Risk zone substation the Network Service Provider must use its best efforts to minimise load shedding by transferring load to other zone substations by utilising available spare capacity.
2.5.4.2 Application of the NCR Criterion

(a) The Network Service Provider may apply the NCR Risk criterion to zone substations in the Perth metropolitan area. Zone substations supplying essential services and zone substations where the application of the NCR Risk criterion is technically or economically unviable may be exempt from classification as NCR classified substations and must fully meet the N-1 planning criteria.

(b) No zone substation may be classified an NCR substation unless a rapid response spare transformer is available to temporarily replace the failed supply transformer within a target period of 12 hours.

(c) Following the loss of a supply transformer from an NCR classified zone substation, the Network Service Provider must use its best efforts to minimise load shedding by transferring load to other supply transformers or zone substations by utilising available spare capacity.

(d) Following the deployment of the rapid response spare transformer, the Network Service Provider must install a suitable spare transformer or procure a new transformer to replace the failed transformer permanently and release the rapid response spare transformer to cater for future contingencies.

2.5.5 High Voltage Distribution System

2.5.5.1 Application of the N-0 criterion

(a) The Network Service Provider may, unless good electricity industry practice dictates otherwise, design and operate the distribution system to the N-0 criterion.

(b) The Network Service Provider may negotiate an enhanced security of supply with Users requiring a high level of supply reliability. Details of the agreed enhanced level of security of supply must be included in the connection agreement. The Network Service Provider is under no obligation to provide a User with an enhanced level of security and Users should note that provision of an enhanced level of security through connection to the transmission or distribution system is often neither economic nor practical. Hence Users requiring an enhanced level of security of supply may need to make alternative arrangements such as the provision of on-site standby generation.

2.5.5.2 Distribution Feeders in the Perth CBD

Distribution feeders in the Perth CBD must be designed so that in the event of an unplanned loss of supply due to the failure of equipment on a high voltage distribution system, the Network Service Provider can use remotely controlled switching to restore supply to those sections of the distribution feeder not directly affected by the fault.
2.5.5.3 **Urban Distribution Feeders**

(a) **Existing Urban Distribution Feeders**

*Urban distribution feeders* in existence at the *Rules commencement date* must be designed so that, in the event of an unplanned single feeder *outage* due to an *equipment* failure within the *zone substation* or a failure of the exit cable, the *load* of that feeder can be transferred to other *distribution feeders* by manual reconfiguration.

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

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

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

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

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

   (B) the feeder(s) picking up the *load* can be from another *zone substation*; and

   (C) any new underground *distribution feeder*, or portion of a new underground feeder that has an installed *transformer* capacity of 1 MVA or more, must be designed so that, as soon as adjacent developments permit, an alternative source of *supply* that is normally open, but can be closed to provide *supply* if a fault occurs on the normal *supply*.

2.5.5.4 **Radial Distribution Feeder Loads in the Perth Metropolitan Area**

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

2.5.5.5 Rural Distribution Feeders

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

2.5.6 Low Voltage Distribution System

2.5.6.1 General

(a) The Network Service Provider may design the radial low voltage distribution systems to the N-0 criterion. However, where technically and commercially feasible, interconnection between low voltage feeders may be provided.

(b) For underground residential subdivisions, the Network Service Provider must ensure that all low voltage circuits have a switching point for every 16 connection points.

2.5.6.2 Pole to Pillar Connection Points Mandatory

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

2.5.7 Fault Limits

The calculated maximum fault level at any point in the transmission and distribution system must not exceed 95% of the equipment fault rating at that point.

2.5.8 Maximum Fault Currents

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

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

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

2. 6.6 kV networks: 21.9 kA
(3) 11 kV networks  25 kA
(4) 22 kV networks  16 kA
(5) 33 kV networks  13.1 kA

(c) Equipment may be installed with a lower fault current rating in accordance with applicable requirements of the Electricity (Supply Standards and System Safety) Regulations 2001 where the fault level is unlikely to exceed the lower rating for credible contingency events.

2.6 DISTRIBUTION DESIGN CRITERIA

(a) All distribution systems must be designed to supply the maximum reasonably foreseeable load anticipated for the area served. The maximum reasonably foreseeable load must be determined by estimating the peak load of the area after it has been fully developed, taking into account restrictions on land use and assuming current electricity consumption patterns.

(b) Distribution systems must be designed to minimise the cost of providing additional distribution system capacity should electricity consumption patterns change.

(c) High voltage switchgear and distribution transformers should be located close to the centre of the loads to be supplied.

(d) The Network Service Provider may remotely monitor and/or control high voltage switchgear where this can be shown to be the most cost efficient approach to meeting the reliability targets set out in the access arrangement.

(e) High voltage switchgear that is not remotely monitored must be fitted with local fault passage indication

(f) Distribution transformers rated at 300 kVA or above must be fitted with load monitoring equipment. This must provide a local indication of actual and peak load and must be capable of being modified in future to enable remote monitoring of the transformer load.

2.7 TRANSMISSION AND DISTRIBUTION SYSTEM DESIGN AND CONSTRUCTION STANDARDS

The Network Service Provider must ensure that the transmission and distribution system complies with these Rules, the Electricity (Supply Standards and System Safety) Regulations 2001, relevant codes standards and regulations, including the Access Code, Australian and International Electricity Commission (IEC) Standards, and relevant Electricity Networks Association Guides.

2.8 DISTRIBUTION CONDUCTOR OR CABLE SELECTION

Extensions and reinforcements to the distribution system must be designed and
constructed in accordance with a *distribution system* concept plan for the area. The installation must conform to the concept plan and use conductors or cables that are:

(a) configured with the objective of minimising the life time cost to the community; and
(b) of a standard carrier size that is equal to or greater than that required for the reasonably foreseeable load.

### 2.9 TRANSMISSION AND DISTRIBUTION SYSTEM PROTECTION

#### 2.9.1 General Requirements

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

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

(c) Protection systems must be designed, installed and maintained in accordance with good electricity industry practice. In particular, the Network Service Provider must ensure that all new protection apparatus complies with IEC Standard 60255 and that all new current transformers and voltage transformers comply with AS 60044 (2003).

#### 2.9.2 Duplication of Protection

(a) **Transmission system**

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

(2) Primary equipment operating at transmission system voltages must also be protected by a *back-up protection system* in addition to the main protection system. The back-up protection system must isolate the faulted primary equipment if a small zone fault occurs, or a circuit breaker failure condition occurs. For primary equipment operating at nominal voltages of 220 kV and above the back-up protection system must comprise two fully independent protection schemes of
differing principle that must discriminate with other protection schemes. For primary equipment operating at nominal voltages of less than 220kV the back-up protection system must incorporate at least one protection scheme to protect against small zone faults or a circuit breaker failure. For protection against small zone faults there must also be a second protection scheme and, where this is co-located with the first protection scheme, together they must comprise two fully independent protection schemes of differing principle.

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

(4) Primary equipment operating at a high voltage that is below a transmission system voltage must be protected by two fully independent protection systems in accordance with the requirements of clause 2.9.2(b)(1).

(b) Distribution system

(1) Each item of primary equipment forming part of the distribution system must be protected by two independent protection systems. One of the independent protection systems must be a main protection system that must remove from service only the faulted item of primary equipment. The other independent protection system may be a back-up protection system.

(2) Notwithstanding the requirements of clause 2.9.2(b)(1), where a part of the distribution system may potentially form a separate island the protection system that provides protection against islanding must comprise two fully independent protection schemes of differing principle and comply with the requirements of clause 2.9.2(a)(3).

2.9.3 Availability of Protection Systems

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

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

(c) Should either the two protection schemes protecting a part of the distribution system be out of service for longer than 48 hours, the Network Service Provider must remove the protected part of the distribution system from service unless
the part of the distribution system must remain in service to maintain power system stability.

### 2.9.4 Maximum Total Fault Clearance Times

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

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

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

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

1. One of the protection schemes of the main protection system must operate to achieve a total fault clearance time no greater than the "No CB Fail" time given in Table 2.10. The other protection scheme of the main protection system must operate to achieve a total fault clearance time no greater than the "No CB Fail" time in Table 2.11. The back-up protection system must achieve a total fault clearance time no greater than the "CB Fail" time in Table 2.10, except that the second protection scheme that protects against small zone faults must achieve a total fault clearance time no greater than 400 msec;

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

3. on 66 kV lines longer than 40 km, one protection scheme of the main protection system must operate to achieve the total fault clearance times specified for 132 kV in Table 2.11 (rather than the times specified in Table 2.10). The other protection scheme of the main protection system must operate to achieve the maximum total fault clearance times specified for 66 kV in Table 2.11.
(e) For a small zone fault coupled with a circuit breaker failure, maximum total fault clearance times are not defined.

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

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

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

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

(g) In Table 2.10 and Table 2.11, for voltages of 66 kV and above, the term "remote end" refers to all circuit breakers required to clear a fault, apart from those specified in clause 2.9.4(f).

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

(h) In Table 2.10, for primary equipment operating at nominal voltages of 33 kV and below, the term “local end” refers only to faults located within the substation in which a circuit breaker is located.

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


### Table 2.10 Maximum total fault clearance times (msec).

<table>
<thead>
<tr>
<th>Voltage Level</th>
<th>Local End</th>
<th>Remote End</th>
<th>Local End</th>
<th>Remote End</th>
</tr>
</thead>
<tbody>
<tr>
<td>220 kV and above</td>
<td>120</td>
<td>180</td>
<td>100</td>
<td>140</td>
</tr>
<tr>
<td>66 kV and 132 kV</td>
<td>150</td>
<td>200</td>
<td>115</td>
<td>160</td>
</tr>
<tr>
<td>33 kV and below</td>
<td>1160</td>
<td>Not defined</td>
<td>1160</td>
<td>Not defined</td>
</tr>
</tbody>
</table>

### Table 2.11 Alternative maximum total fault clearance times (msec) for 132 kV and 66 kV lines.

<table>
<thead>
<tr>
<th>Voltage Level</th>
<th>Existing Equipment No CB Fail</th>
<th>Existing Equipment CB Fail</th>
<th>New Equipment No CB Fail</th>
<th>New Equipment CB Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>132 kV Local end</td>
<td>150</td>
<td>400</td>
<td>115</td>
<td>310</td>
</tr>
<tr>
<td>132 kV Remote end</td>
<td>400</td>
<td>650</td>
<td>400</td>
<td>565</td>
</tr>
<tr>
<td>66 kV Local end</td>
<td>1000</td>
<td>Not defined</td>
<td>115</td>
<td>310</td>
</tr>
<tr>
<td>66 kV Remote end</td>
<td>Not defined</td>
<td>Not defined</td>
<td>400</td>
<td>565</td>
</tr>
</tbody>
</table>

#### 2.9.5 Critical Fault Clearance Times

(a) Notwithstanding the requirements of clause 2.9.4, where necessary to ensure that the power system complies with the performance standards specified in clause 2.2, the Network Service Provider may designate a part of the transmission or distribution system.
distribution system as subject to a critical fault clearance time. The critical fault clearance time may be lower than the standard maximum total fault clearance time set out in Table 2.10. The network configurations to which the critical fault clearance time applies shall be specified by the Network Service Provider.

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

2.9.6 Protection Sensitivity

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

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

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

2.9.7 Trip Supply Supervision Requirements

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

2.9.8 Trip Circuit Supervision Requirements

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

2.9.9 Protection Flagging and Indication

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

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

3.1 INTRODUCTION

(a) This section 3 sets out details of the technical requirements which Users must satisfy as a condition of connection of any equipment to the transmission and distribution systems (including embedded generating units), except where granted an exemption by the Network Service Provider in accordance with sections 12.33 to 12.39 or the Authority in accordance with sections 12.40 to 12.49 of the Access Code.

(b) This section 3 assumes the times a User’s facility may operate will not be restricted, except in accordance with these Rules. Additional operating restrictions may be agreed by a Network Services Provider and a User. In such circumstances the Network Services Provider may impose requirements over and above those shown in this section 3 to ensure that the User’s facility only operates in accordance with the agreed restrictions. The additional operating restrictions and any additional requirements must be specified in the relevant connection agreement.

(c) The objectives of this section 3 are to facilitate maintenance of the power system performance standards specified in section 2.2, so that other Users are not adversely affected and that personnel and equipment safety are not put at risk following, or as a result of, the connection of a User’s equipment.

The scope of these Rules does not include the technical requirements for the provision of ancillary services either in accordance with the relevant provisions of the Market Rules or under a commercial arrangement with the Network Services Provider. Users who provide these ancillary services may be required to comply with technical requirements over and above those specified in this section 3. These additional requirements will be specified in the relevant ancillary services contract.

3.2 REQUIREMENTS FOR ALL USERS

3.2.1 Power System Performance Standards

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

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

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

(c) **Harmonics**

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

2. Where no harmonic injection limit has been allocated in accordance with clause 2.3.4(a), a *User* must ensure that the injection of harmonics or interharmonics from its *equipment* or *facilities* into the *transmission* or *distribution systems* does not cause the maximum system harmonic *voltage* levels set out in Table 2.4 and Table 2.5 to be exceeded at the point of connection.

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

(d) **Negative Phase Sequence Voltage**

1. A *User connected* to all three phases must balance the current drawn in each phase at its *connection point* so as to achieve 10-minute average levels of negative sequence *voltage* at the *connection point* that are equal to or less than the values set out in Table 2.6.

2. A *User* directly *connected* to the *transmission system* must be connected to all three phases.

(e) **Electromagnetic Interference**

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

(f) **Fault Levels**

1. A *User connected* to the *transmission system* may not install or connect *equipment* at the *connection point* that is rated for a *maximum fault current* lower than that specified in the *connection agreement* in accordance with clause 2.5.7(a).

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

(3) Small use customers connected to the distribution system may install equipment with a fault level with a lower fault rating than the maximum fault current specified in clause 2.5.8(b)(1) in accordance with the applicable requirements of the WA Electrical Requirements.

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

3.2.2 Main Switch

Except as provided in clause 3.3.3.10, a User must be able to de-energise its own equipment without reliance on the Network Service Provider.

3.2.3 User's Power Quality Monitoring Equipment

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

(b) The key inputs that the Network Service Provider may require a User to provide to the Network Service Provider's power quality monitoring and recording equipment include:

(1) three phase voltage and three phase current and, where applicable, neutral voltage and current; and

(2) digital inputs for circuit breaker status and protection operate alarms hardwired directly from the appropriate devices. If direct hardwiring is not possible and if the Network Service Provider agrees, then the User may provide inputs measurable to 1 millisecond resolution and GPS synchronised.

3.2.4 Power System Simulation Studies

(a) A User must provide to the Network Service Provider such of the following information relating to any of the User's facilities connected or intended to be connected to the transmission system as is required to enable the undertaking of power system simulation studies:
(1) a set of functional block diagrams, including all transfer functions between feedback signals and generating unit output;

(2) the parameters of each functional block, including all settings, gains, time constraints, delays, dead bands and limits; and

(3) the characteristics of non-linear elements.

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

3.2.5 Technical Matters to be Coordinated

A User and the Network Service Provider must agree upon the following matters for each new or altered connection:

(a) design at the connection point;
(b) protection;
(c) control characteristics;
(d) communications, remote controls, indications and alarms;
(e) insulation co-ordination and lightning protection;
(f) fault levels and total fault clearance times;
(g) switching and isolation facilities;
(h) interlocking arrangements;
(i) synchronising facilities;
(j) provision of information;
(k) computer model and power system simulation study requirements;
(l) load shedding and islanding schemes; and
(m) any special test requirements.
3.3 REQUIREMENTS FOR CONNECTION OF GENERATING UNITS

3.3.1 General

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

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

(c) For generating equipment the combined rating of which is less than 10 MW and which is connected to the distribution system, the connection requirements of clause 3.6 or clause 3.7 apply. This clause 3.3 applies to generating equipment the combined rating of which is 10 MW or greater.

The 10 MW threshold is chosen to coincide with the cut-off size for compulsory participation in the Electricity Market. Electricity Market participation is compulsory for generating equipment rated 10 MW and above.

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

(1) reduced rotor angle stability;
(2) reduced frequency stability; or
(3) reduced voltage stability,

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

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

(e) An unplanned trip of a generating unit must not cause an increased need for load shedding because of:

(1) rate of change of frequency;
(2) magnitude of frequency excursion;
(3) active power imbalance;
(4) reactive power imbalance; or
(5) displacement of reactive capability,

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

The effect of this clause is to limit the maximum generating unit size that is permitted to connect to the transmission or distribution system without taking an appropriate action to rectify the potential problem.

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

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

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

3.3.2 Provision of Information

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

(b) Details of the kinds of data that may be required are included in Attachment 3, Attachment 4, and Attachment 5.

3.3.3 Detailed Technical Requirements Requiring Ongoing Verification

A Generator must verify compliance of its own equipment with the technical requirements of this clause 3.3.3 by the methods described in clause 4.1.3.

3.3.3.1 Reactive Power Capability

(a) Each generating unit, and the power station in which the generating unit is located, must be capable of continuously providing the full reactive power output required under this clause 3.3.3.1 within the full range of steady state voltages at the connection point permitted under clause 2.2.2.
This requirement must be met for all operating conditions, including ambient temperature. Unless operating restrictions have been agreed in accordance with clause 3.1(b), the Network Service Provider may assume the site specific maximum ambient temperature shown in the figure below when assessing compliance with the requirements of this clause.

(b) Each generating unit must include a controller that is capable of varying the reactive power at the connection point between the maximum import level and maximum export level required by this clause 3.3.3.1. This control must be continuous to the extent that it must not depend on mechanically switched devices other than an on-load tap changer forming part of the generating unit transformer.

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

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

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

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

Refer to Figure 3.1 for details.

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

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

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

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

(3) Where necessary to meet the performance standards specified in clause 2.2, the Network Service Provider may require an induction
generating unit to be capable of supplying or absorbing a greater amount of reactive power output than specified in clause 3.3.3.1(c)(2). The need for such a requirement will be determined by power system simulation studies and any such a requirement must be included in the connection agreement.

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

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

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

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

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

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

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

(f) If the voltage at the connection point falls below the steady state level permitted by clause 2.2.2, the output current of the facility must not be less than the output current of the facility if it was providing the maximum reactive power required by this clause 3.3.3.1 when generating its maximum rated active power with the connection point at nominal voltage.
(g) The Network Service Provider may agree not to require full compliance with the requirements of this clause 3.3.3.1 in return for a capital contribution towards the provision of new sources of reactive power within the transmission or distribution network. The basis for determining the required capital contribution must be the additional capital cost that the proponent would reasonably be expected to incur if full compliance with the requirements of this clause was not waived.

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

3.3.3.2 Generating Unit Performance Standard

A synchronous generating unit or an induction generating unit must be designed to generate a constant voltage level with balanced phase voltages and harmonic voltage distortion equal to or less than permitted in accordance with either Australian Standard AS 1359 (1997) "General Requirements for Rotating Electrical Machines" or a recognised equivalent international standard as agreed between the Network Service Provider and the User if the generating unit was not connected to the transmission or distribution system.

3.3.3.3 Generating Unit Response to Disturbances in the Power System

(a) Overview

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

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

(b) Immunity to Frequency Excursions:

A generating unit and a power station in which the generating unit is located must be capable of continuous uninterrupted operation within the power system frequency envelope specified in Figure 3.4. Operation for a period of at least 10 seconds is required each time the frequency is below 47.5 Hz. Operation for a period of at least 6 seconds is required each time the frequency is above 52 Hz. Below 47 Hz and above 52.5 Hz, instantaneous disconnection of generating units is permitted.
Figure 3.4 – Off nominal frequency operation capability requirement for generating units

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

(c) Immunity to Voltage Excursions:

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

(2) Notwithstanding the requirements of clause 3.3.3.3(c)(1) no generating unit shall be required to be capable of continuous
uninterrupted operation where the voltage at the connection point falls below the envelope shown in Figure 3.5.

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

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

A generating unit and the power station in which the generating unit is located must be capable of continuous uninterrupted operation for any rate-of-change-of-frequency of up to 4 Hz per second.

(e) **Immunity to High Speed Auto Reclosing:**

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

Nominal Voltage

0% 0 0.160 1.660 1.820 11.820 time (seconds)

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

After fault clearing, the power station in which a non-synchronous generating unit is located must not absorb reactive power from the transmission system or the distribution system. Any pre-fault absorption of reactive power has to be terminated within 200 ms after clearing of the fault. The absorption is permitted to recommence, if required by the applicable voltage control strategy, after the post-fault voltages stabilize for at least 60 seconds at an above nominal value.

This requirement is intended for undervoltage situations where a generator is potentially exacerbating the problem.

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

Each generating unit must be fitted with an active power output controller, such as a governor, and a voltage regulator so that, following the occurrence of any credible contingency event and changed power system conditions after disconnection of the faulted element, the generating unit must be capable of delivering to the transmission or distribution system active power and reactive power sufficient to ensure that the connection point voltage is within the range for continuous uninterrupted operation for that generating unit.

(h) **Continuous Uninterrupted Operation:**
For the purposes of this clause 3.3.3.3, a generating unit is considered to remain in continuous uninterrupted operation if:

1. the generating unit is not disconnected from the transmission or distribution system due to protection system operation;

2. the active power output returns to the generating unit's pre-fault electric power output within 200 milliseconds after the voltage has returned to between 80% to 110% of nominal voltage. In making this assessment allowances may be made for:
   (A) any variation in active power output for non-synchronous generating units due to variation in the primary source of energy; and
   (B) any variation in active power output of synchronous generating units due to any reduction in the power system frequency in accordance with the registered capability of the generating unit.

3. the reactive power control mode in which the generating unit was operating prior to the credible contingency event occurring does not change, unless it is required by clause 3.3.3.3(f).

3.3.3.4 Sudden Reduction in Active Power Requirement

A generating unit must be capable of continuous uninterrupted operation as defined in clause 3.3.3.3(h) during and following a sudden reduction in required active power generation imposed from the power system, provided that the reduction is less than 30% of the generator machine’s nameplate rating and the required active power generation remains above the generating unit’s registered minimum active power generation capability.

3.3.3.5 Ramping Rates

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

(b) A power station that is not subject to dispatch by System Management must not increase or decrease its active power generation at a rate greater than 10MW per minute or 15% of the power station’s aggregate nameplate rating per minute, whichever is the greater, except when more rapid changes are necessary due to the strength of the energy source moving outside the power station’s design range.
This requirement would normally be incorporated into the design of the active power output controller.

3.3.3.6 Safe Shutdown without External Electricity Supply

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

3.3.3.7 Restart Following Restoration of External Electricity Supply

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

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

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

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

3.3.3.8 Protection of Generating Units from Power System Disturbances

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

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

1. loss of synchronism;
2. high or low frequency outside the generator off-nominal frequency operation capability requirements specified in Figure 3.4;
(3) sustained excessive generating unit stator current that cannot be automatically controlled;

(4) high or low stator voltage outside generator machine rating;

(5) voltage to frequency ratio outside generator machine rating;

(6) negative phase sequence current outside generator machine rating; and

(7) any similar condition agreed between the Generator and the Network Service Provider after consultation with System Management.

(c) The actual design and settings of the protection equipment installed in order to disconnect a generating unit in accordance with clause 3.3.3.8(a) must be consistent with power system performance requirements specified in section 2 and must be approved by the Network Service Provider.

3.3.3.9 Generating Unit Transformer

(a) Transformer Impedance:

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

(b) Vector Group:

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

(c) Tap Changing:

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

3.3.3.10 De-energisation of Generator Circuits

The Network Service Provider's relevant circuit breaker may be used as a point of de-energisation, instead of the main switch specified in clause 3.2.2 provided that the Generator meets the following requirements:

(a) the Generator must be able to synchronise any parallel generating equipment to the transmission or distribution system across a circuit breaker owned by the Generator;

(b) the Generator must be able to clear a fault on its equipment:
(1) without adversely affecting any other User or potential User; and

(2) within the fault clearance times specified in clause 3.5.2(b);

provided that the substation where the Network Service Provider’s relevant circuit breaker is located is in its normal operating configuration.

(c) if:

(1) the Generator has only one circuit at the connection point; and

(2) the Network Service Provider's relevant circuit breaker is located in a meshed substation,

and if:

(3) the Generator's facilities are continuously manned with personnel capable of resetting a hand-reset protection relay; or

(4) the Generator's facilities have self-resetting relays,

then the Generator may de-energise its equipment by sending a trip signal to the Network Service Provider's relevant circuit breaker.

(d) the Generator must own a visible point of isolation between the Network Service Provider's relevant circuit breaker and the Generator's equipment for each piece of equipment connected to the transmission or distribution system.

Under the relevant connection agreement, the Network Service Provider will require the Generator to indemnify the Network Service Provider from any and all liability for any direct or indirect damage caused to the User as a result of the Generator's electing to use any Network Service Provider's circuit breaker to clear a fault under clause 3.3.3.10(c).

3.3.4 Monitoring and Control Requirements

3.3.4.1 Remote Monitoring

(a) The Network Service Provider or System Management may require a User to:

(1) provide remote monitoring equipment (RME) to enable the Network Service Provider or System Management to monitor performance of a generating unit (including its dynamic performance) remotely where this is necessary in real time for control, planning or security of the power system; and

(2) upgrade, modify or replace any RME already installed in a power station provided that the existing RME is, in the opinion of the Network Service Provider, no longer fit for purpose and notice is given in writing to the relevant Generator accordingly.
(b) Any RME provided, upgraded, modified or replaced (as applicable) under clause 3.3.4.1(a), must conform to an acceptable standard as agreed by the Network Service Provider and must be compatible with the Network Service Provider's and System Management's SCADA system.

(c) Input information to RME may include the following:

1) Status Indications
   (A) generating unit circuit breaker open/closed (dual point);
   (B) remote generation load control on/off;
   (C) generating unit operating mode;
   (D) turbine control limiting operation; and
   (E) connection to the transmission or distribution system;

2) Alarms
   (A) generating unit circuit breaker / main switch tripped by protection;
   (B) prepare to off load; and
   (C) protection defective alarms;

3) Measured Values
   (A) transmission system:
      (i) gross active power output of each generating unit;
      (ii) gross reactive power output of each generating unit;
      (iii) net station active power import or export at each connection point;
      (iv) net station reactive power import or export at each connection point;
      (v) generating unit stator voltage;
      (vi) generating unit transformer tap position;
      (vii) net station output of active energy (impulse);
(viii) generating unit remote generation control high limit value;

(ix) generating unit remote generation control low limit value; and

(x) generating unit remote generation control rate limit value;

(B) distribution system:

(i) main switch active power import or export;

(ii) main switch reactive power import or export; and

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

(4) such other input information reasonably required by the Network Service Provider or System Management.

3.3.4.2 Remote control

(a) The Network Service Provider or System Management may, for any generating unit which may be unattended when connected to the transmission or distribution system, require the Generator to:

(1) provide remote control equipment (RCE) to enable the Network Service Provider or System Management to disconnect a generating unit from the transmission or distribution system; and

(2) upgrade, modify or replace any RCE already installed in a power station provided that the existing RCE is, in the opinion of the Network Service Provider or System Management, no longer fit for purpose and notice is given in writing to the relevant User accordingly.

(b) Any RCE provided, upgraded, modified or replaced (as applicable) under clause 3.3.4.2(a) must conform to an acceptable standard as agreed by the Network Service Provider and must be compatible with the Network Service Provider's SCADA system, including the requirements of clause 5.11.

3.3.4.3 Communications Equipment

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

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

(c) Primary Speech Communication Channel

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

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

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

(d) Back-up Speech Communications Channel

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

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

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

3.3.4.4 Frequency Control

(a) All generating units must have an automatic variable load control characteristic. Turbine control systems must include facilities for both speed and load control.

(b) Generating units must be capable of operation in a mode in which they will automatically and accurately alter active power output to allow for changes in the relevant dispatch level and for changes in frequency of the transmission and distribution system and in a manner to sustain high initial response.
(c) A Generator must, operate a generating unit in the mode specified in clause 3.3.4.4(b) unless instructed otherwise by System Management or the Network Service Provider, as the case requires.

(d) **Dead band**

The dead band of a generating unit (the sum of increase and decrease in power system frequency before a measurable change in the generating unit's active power output occurs) must be less than 0.05 Hz.

(e) **Control Range**

(1) For dispatchable generating units:

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

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

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

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

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

(f) **Rate of Response**

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

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

3.3.4.5 Voltage Control System

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

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

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

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

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

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

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

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

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

(d) Synchronous generating units with ratings in excess of 30 MW or smaller generating units within a power station with a total active power output capability in excess of 30 MW must incorporate power system stabiliser (PSS)
circuits which modulate the generating unit field voltage in response to changes in power output and/or shaft speed and/or any other equivalent input signal approved by the Network Service Provider. The stabilising circuits must be responsive and adjustable over a frequency range which must include frequencies from 0.1 Hz to 2.5 Hz. Power system stabiliser circuits may be required on synchronous generating units with ratings less than or equal to 30 MW or smaller synchronous generating units within a power station with a total active power output capability less than or equal to 30 MW if power system simulations indicate a need for such a requirement. Before commissioning of any power system stabiliser, the Generator must propose preliminary settings for the power system stabiliser, which must be approved by the Network Service Provider

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

(f) The performance characteristics required for AC exciter, rotating rectifier and static excitation systems are specified in Table 3.1:
Table 3.1 Synchronous generator excitation control system performance requirements

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

**Notes:**
1. One per unit excitation voltage is that field voltage required to produce nominal voltage on the air gap line of the generating unit open circuit characteristic (Refer IEEE Standard 115-1983 - Test Procedures for Synchronous Machines). Excitation control system with both proportional and integral actions must achieve a minimum equivalent gain of 200.
2. Rated field voltage is that voltage required to give nominal generating unit terminal voltage when the generating unit is operating at its maximum continuous rating. Rise time is defined as the time taken for the field voltage to rise from 10% to 90% of the increment value.

3. Settling time is defined as the time taken for the generating unit terminal voltage to settle and stay within an error band of ±10% of its increment value.

4. Field voltage means generating unit field voltage.

(g) The performance characteristics required for the voltage or reactive power control systems of all non-synchronous generating units are specified in Table 3.2:

Table 3.2 Non-synchronous generator voltage or reactive power control system performance requirements

<table>
<thead>
<tr>
<th>Performance Item</th>
<th>Units</th>
<th>Limiting Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity:</td>
<td>Gain (ratio)</td>
<td>200 minimum</td>
<td>1</td>
</tr>
<tr>
<td>A sustained 0.5% error between the reference voltage and the sensed voltage must produce an output change of not less than 100% of the reactive power generation capability of the generating unit, measured at the point of control.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rise time:</td>
<td>second</td>
<td>1.5 maximum</td>
<td>2</td>
</tr>
<tr>
<td>Time for the controlled parameter (voltage or reactive power output) to rise from the initial value to 90% of the change between the initial value and the final value following the application of a 5% step change to the control system reference.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Small disturbance settling time**

Settling time of the controlled parameter with the generating unit connected to the transmission or distribution network following a step change in the control system reference that is not large enough to cause saturation of the controlled output parameter. Must be met at all operating points within the generating unit’s capability.

<table>
<thead>
<tr>
<th>second</th>
<th>2.5</th>
<th>3</th>
</tr>
</thead>
</table>

**Large disturbance settling time**

Settling time of the controlled parameter following a large disturbance, including a transmission or distribution network fault, which would cause the maximum value of the controlled output parameter to be just exceeded.

<table>
<thead>
<tr>
<th>second</th>
<th>5</th>
<th>3</th>
</tr>
</thead>
</table>

**Notes:**

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

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

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

(j) Control system settings may require alteration from time to time as advised by the Network Service Provider. The preliminary settings backed up by any calculations and system studies to derive these settings must be provided by the Network Service Provider at least two months before the system tests stated in clause 4.1.3 are undertaken. A Generator must cooperate with the Network Service Provider by applying the new settings and participating in tests to demonstrate their effectiveness.
(k) Excitation limiters must be provided for under excitation and over excitation of synchronous generating units and may be provided for voltage to frequency ratio. The generating unit must be capable of stable operation for indefinite periods while under the control of any limiter. Limiters must not detract from the performance of any stabilising circuits and must have settings applied which are coordinated with all protection systems.

3.3.5 Power station Auxiliary Transformers

In cases where a power station takes its auxiliary supplies through a transformer by means of a separate connection point, the User must comply with the conditions for connection of loads (refer to clause 3.4) in respect of that connection point.

3.3.6 Synchronising

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

(b) The Generator must provide check synchronising on all generating unit circuit breakers and any other circuit breakers, unless interlocked (as outlined in clause 3.4), that are capable of connecting the User's generating equipment to the transmission or distribution system.

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

3.3.7 Secure Electricity Supplies

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

3.3.8 Design Requirements For Generator’s Substations

A Generator must comply with the requirements of clause 3.4.8.

3.3.9 Computer Model

(a) A Generator must provide a software model of each generating unit suitable for use in the software package which is used by the Network Service Provider at the time of signing the relevant connection agreement. The model must automatically initialise its parameters from load flow simulations. Once a simulation case has been compiled, changes in the load flow such as changes in voltage, generating unit output, voltage set point must not require the study case to be recompiled. It is the preference of the Network Service Provider that the model be made available to the provider for inclusion in the standard software package library. The source code of the model must also be provided.
(b) Generators must demonstrate to the satisfaction of the Network Service Provider that the model adequately represents the performance of the generating unit over its load range and over the system frequency operating range of clause 2.2.1, Table 2.1. The normal method of model verification is through testing.

(c) The structure and parameter settings of all components of the turbine and excitation control equipment must be provided to the Network Service Provider in sufficient detail to enable the dynamics of these components to be characterised in the computer model for short and long term simulation studies. This must include a control block diagram in suitable form to perform dynamic simulations and proposed and final parameter settings for the turbine and excitation control systems for all expected modes of turbine control system operation. The final parameter settings must not be varied without prior approval of the Network Service Provider.

(d) The applicable structure and parameter settings include:

1. speed/load controller;
2. key protection and control loops;
3. actuators (for example hydraulic valve positioning systems); and
4. limiters.

(e) A Generator may connect to the transmission or distribution system without fully complying with the requirements of subclauses (a) to (d) of this clause 3.3.9 provided that the Generator agrees in the relevant connection agreement to alternative arrangements, acceptable to the Network Service Provider, for the provision of a compatible software model of the generating unit should the Network Service Provider upgrade or change its power system simulation software.

(f) A Generator that was connected to the transmission or distribution system prior to the rules commencement date, and which has not fully complied with the requirements of subclauses (a) to (d) of this clause 3.3.9, must support the computer model for changes in the nominated software for the duration of its connection to the transmission or distribution system.

3.4 REQUIREMENTS FOR CONNECTION OF LOADS

3.4.1 Obligations of Consumers

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

1. as set out in this clause 3.4; and
(2) in accordance with any relevant connection agreement with the Network Service Provider.

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

3.4.2 Overview

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

(b) The requirements set out in this clause 3.4 generally apply to the connection of a large load to the transmission or distribution network. The specific requirements for the connection of a particular Consumer's equipment and facilities must be determined by the Network Service Provider and will depend on the magnitude and other characteristics of the Consumer's load, the power transfer capacity, voltage and location of the connection point, and characteristics of the local transmission or distribution system in the vicinity of the connection point.

(c) A Consumer must provide equipment capabilities, protection and control systems that ensure that its load:

(1) does not cause excessive load fluctuations, reactive power draw or, where applicable, stalling of motor loads that would have an adverse impact on other Users, System Management, the Network Service Provider or the performance of the power system.

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

(A) frequency stability, or

(B) voltage stability,

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

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

3.4.3 Power Frequency Variations

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

A *Consumer* must ensure that the *equipment connected to its connection point* is capable of continuous uninterrupted operation (other than when the *facility* is faulted) if variations in *supply voltage* of the kind described in clause 2.2.2 occur.

3.4.5 ** Provision of Information**

(a) Before *connection* to the *transmission or distribution system*, a *Consumer* must provide all data relevant to each *connection point* that is required by the *Network Service Provider* in order to complete the detailed design and installation of the relevant *connection assets*, to ensure that there is sufficient *power transfer capability* in the *transmission and distribution systems* to supply the *Consumer's load* and that connection of the *Consumer's load* will not have an adverse impact on other *Users*, or on the performance of the *power system*.

(b) The specific data that must be provided by a *Consumer* in respect of a particular *connection point* will depend on characteristics of the *Consumer's loads*, the *power transfer capacity* of the *connection point* as specified in the relevant *connection agreement*, the *voltage* and location of the *connection point*, and characteristics of the local *transmission or distribution system* in the vicinity of the *connection point*. *Equipment* data that may need to be provided includes:

1. interface *protection* details including, line diagram, grading information, secondary injection and trip test certificate on all circuit breakers;
2. metering system design details for *equipment* being provided by the *Consumer*;
3. a general arrangement locating all the major *loads* on the site;
4. a general arrangement showing all exits and the position of all electrical *equipment* in *substations* that are directly *connected* to the *connection point*;
5. type test certificates for new switchgear and *transformers*, including measurement *transformers* to be used for metering purposes;
6. the proposed methods of earthing cables and other *equipment* plus a single line earthing diagram;
7. *equipment* and earth grid test certificates from approved test authorities;
8. operational procedures;
9. details of time-varying, non-sinusoidal and potentially disturbing *loads*;
(10) SCADA arrangements;
(11) load details including maximum demand profiles;
(12) a line diagram and service or incoming cable routes and sizes; and
(13) preferred location of the connection point.

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

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

3.4.6 Design Standards

(a) The equipment connected to a Consumer’s connection point must comply with the relevant Australian Standards as applicable at the time of first installation of the equipment, the Electricity (Supply Standard and System Safety) Regulations 2001 (WA), good electricity industry practice and these Rules and it must be capable of withstanding the power frequency voltages and impulse levels specified by the Network Service Provider.

(b) The circuit breakers, fuses and other equipment provided to isolate a Consumer’s facilities from the transmission and distribution system in the event of a fault must be capable of breaking, without damage or restrike, the fault currents specified by the Network Service Provider for the relevant connection point.

(c) The equipment ratings connected to a Consumer’s connection point must coordinate with the equipment installed on the power system.

3.4.7 Power factor Requirements

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

<table>
<thead>
<tr>
<th>Permissible Range</th>
<th>Power factor range (half-hour average, unless otherwise specified by the Network Service Provider)</th>
</tr>
</thead>
</table>
| Supply Voltage (nominal) | 220kV / 330 kV: 0.96 lagging to unity  
|                     | 66kV / 132 kV: 0.95 lagging to unity  
|                     | <66kV: 0.9 lagging to 0.9 leading |

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

(c) The Network Service Provider may permit a lower lagging or leading power factor where this will not reduce system security and/or quality of supply, or require a higher lagging or leading power factor to achieve the power transfers required by the load.

(d) A shunt capacitor installed to comply with power factor requirements must comply with the Network Service Provider's requirements to ensure that the design does not severely attenuate audio frequency signals used for load control or operations.

(e) A static VAr compensator system installed for either power factor or quality of supply requirements must have a control system that does not interfere with other control functions on the electricity transmission and distribution system. Adequate filtering facilities must be provided if necessary to absorb any excessive harmonic currents.

3.4.8 Design Requirements for Consumers' Substations

Equipment in or for any Consumer’s substation that is connected directly to a connection point must comply with the following requirements:

(a) safety provisions that comply with the requirements of the Network Service Provider must be incorporated into the substation facilities;

(b) where required by the Network Service Provider, interfaces and accommodation must be provided by the User for metering, communication, remote monitoring and protection equipment to be installed in the substation by the Network Service Provider;
(c) the substation must be capable of continuous uninterrupted operation within the system performance standards specified in section 2.2;

(d) the transformer vector group must be agreed with the Network Service Provider. The vector group must be compatible with the power system at the connection point and preference be given to vector groups with a zero sequence opening between high voltage and low voltage windings.

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

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

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

3.4.9 Load shedding Facilities

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

3.4.9.1 Installation and Testing of Load shedding Facilities

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

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

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

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

(d) apply undervoltage settings to relays as determined by the Network Service Provider.
3.4.10 Monitoring and Control Requirements

3.4.10.1 Remote Monitoring

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

(1) provide remote monitoring equipment, (RME) to enable System Management or the Network Service Provider to monitor the status and indications of the load remotely where this is necessary in real time for management, control, planning or security of the power system; and

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

(b) An RME provided, upgraded, modified or replaced (as applicable) in accordance with clause 3.4.10.1(a) must conform to an acceptable standard as agreed by the Network Service Provider and must be compatible with the Network Service Provider's SCADA system, including the requirements of clause 5.11.

(c) Input information to RME may include the following:

(1) status indications

(A) relevant circuit breakers open/closed (dual point) within the equipment;

(B) relevant isolators within the equipment;

(C) connection to the transmission or distribution system; and

(D) relevant earth switches;

(2) alarms

(A) protection operation;

(B) protection fail;

(C) battery fail - AC and DC;

(D) trip circuit supervision; and

(E) trip supply supervision;

(3) measured values
(A) active power load;
(B) reactive power load;
(C) load current; and
(D) relevant voltages throughout the equipment, including voltage on the Network Service Provider side of main switch.

3.4.10.2 Network Service Provider's Communications Equipment

Where remote monitoring equipment is installed in accordance with clause 3.4.10.1, the User must provide communications paths (with appropriate redundancy) between the remote monitoring equipment and a communications interface in a location reasonably acceptable to the Network Service Provider. Communications systems between this communications interface and the relevant control centre are the responsibility of the Network Service Provider unless otherwise agreed.

3.4.11 Secure Electricity Supplies

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

3.5 User's Protection Requirements

3.5.1 Overview

(a) The requirements of this clause 3.5 apply only to a User's protection system that is necessary to maintain power system security. Protection systems installed solely to cover risks associated with a User's equipment are at the User's discretion. The extent of a User's equipment that will need to conform to the requirements of this clause 3.5 will vary from installation to installation. Consequently, each installation will need to be assessed individually by the Network Service Provider. Information that may be required by the Network Service Provider in order to complete this assessment is specified in Attachment 5.

(b) The requirement for protection systems in respect of any User's equipment that forms an integral part of the transmission or distribution system (as seen from the transmission or distribution system) is the same as would apply under clause 2.9 if that equipment were the Network Service Provider's equipment. For the purposes of this clause 3.5.1(b) a User's equipment forms an integral part of the transmission and distribution system when the connection asset (such as a circuit breaker) that is used to disconnect a User's equipment from the transmission or distribution system is owned by a User.
(c) All Users’ equipment connected to the transmission or distribution system must be protected by protection systems or devices that automatically disconnect any faulty circuit from the transmission or distribution system.

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

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

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

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

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

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

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

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

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

3.5.2 Specific Protection Requirements for Generator Facilities

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

(b) The protection system for a generating unit must be designed to protect the generating unit from faults on the transmission or distribution system and to minimise damage to the generating unit from infeeds from the transmission and
distribution system in the event of an internal fault. The main protection system must incorporate two fully independent protection schemes of differing principle, each discriminating with the transmission and distribution system. Where a critical fault clearance time exists, each protection scheme must be capable of operating to achieve the critical fault clearance time. Where there is no critical fault clearance time both independent protection schemes must meet the relevant maximum total fault clearance times specified in clause 2.9.4.

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

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

1. disconnection of the Generator's generation from the transmission and distribution systems if any of the protection schemes required by clause 3.5.2(b) operate;
2. separation of the Generator's generating unit from the transmission and distribution systems if there is a loss of supply to the User's installation from the transmission and distribution systems;
3. prevention of the Generator's generating unit from energising de-energised Network Service Provider equipment, or energising and supplying an otherwise isolated portion of the transmission or distribution system except where a Generator is contracted under the Market Rules to provide a black start ancillary service and is directed to provide this service by System Management;
4. adequate protection of the Generator's equipment without reliance on back up from the Network Service Provider's protection apparatus except as agreed with the Network Service Provider in accordance with clause 3.3.3.10 or 3.5.1(d); and
5. detection of a failure of a Generator's circuit breaker to clear a fault due to either mechanical or electrical failure. If such a failure is detected, the Generator User's protection system must send a trip signal to an alternative circuit breaker, which may be provided by the Network Service Provider in accordance with clause 3.5.1(d), in order to clear the fault.

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

(f) If a generating unit is connected to the distribution system the Generator must provide a circuit breaker close inhibit interlock with the feeder circuit breaker at
SECTION 3 – TECHNICAL REQUIREMENTS OF USER FACILITIES

the Network Service Provider's zone substation in accordance with the requirements specified by the Network Service Provider.

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

3.5.3 Specific Protection Requirements for Consumer Facilities

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

(b) If the Consumer's connection point has a nominal voltage of 66 kV or greater, the main protection system must:

(1) have sufficient redundancy to ensure that a faulted element is disconnected from the power system within the applicable fault clearance time as determined in accordance with clause 3.5.3(a) with any single protection element (including any communications facility upon which the protection system depends) out of service;

(2) provide a circuit breaker failure protection scheme to clear faults that are not cleared by the circuit breakers controlled by the primary protection system within the applicable fault clearance time as determined in accordance with clause 3.5.3(a). If a circuit breaker fails, the Consumer's protection system may send a trip signal to a circuit breaker provided by the Network Service Provider in accordance with clause 3.5.1(d), in order to clear the fault.
3.6 REQUIREMENTS FOR CONNECTION OF SMALL GENERATING UNITS TO THE DISTRIBUTION NETWORK

3.6.1 Overview

This clause 3.6 addresses the particular requirements for the connection of small generating units and groups of small generating units of aggregate rated capacity up to 10 MW (small power stations) to the distribution system where such generating units are not subject to dispatch by System Management in accordance with the Market Rules. This does not apply to the connection of energy systems rated at up to 30 kVA and connected to the low voltage system via inverters, in respect of which clause 3.7 applies.

The issues addressed by this clause 3.6 are:

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

2. the possibility that a small power station or a number of small generating units connected to the distribution system could become islanded on to a part of the distribution system that has become disconnected from the power system, resulting in safety and quality of supply concerns.

3.6.2 Categorisation of Facilities

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

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

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

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

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

(3) Where a small power station is the only facility connected to a low voltage network the Generator may choose to have the power station assessed for compliance as if the power station was high voltage connected. Prior to another User subsequently connecting to the same low voltage network the Network Service Provider must reassess the
power station for compliance with the requirements for low voltage connected power stations and the Generator must rectify any non-compliance identified in the reassessment.

(d) **Modes of Operation**

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

1. being in continuous parallel operation with the distribution system, and either exporting electricity to the distribution system or not exporting electricity to it;

2. being in occasional parallel operation with the distribution system, and either exporting electricity to the distribution system or not exporting electricity to it, including generating units participating in peak lopping and system peak load management for up to 200 hours per year;

3. being in short term test parallel operation with the distribution system, and either exporting electricity to the distribution system or not exporting electricity to it, and having a maximum duration of parallel operation 2 hours per event and 24 hours per year; or

4. bumpless (make before break) transfer operation, being:
   - (A) operation in rapid transfer mode where, when load is transferred between the generating unit and the distribution system or vice versa, the generating unit is synchronised for a maximum of one second per event; or
   - (B) operation in gradual transfer mode where, when load is transferred between the generating unit and the distribution system or vice versa, the generating unit is synchronised for a maximum of 60 seconds per event.

3.6.3 **Information to be provided by the Generator**

(a) A Generator must provide to the Network Service Provider information in relation to the design, construction, operation and configuration of that small power station as is reasonably required to ensure that the operation and performance standards of the distribution system, or other Users, are not adversely affected by the operation of the power station. Details of the kinds of information that may be required are included in Attachment 10. Where considered necessary by the Network Service Provider additional information of the kind included in Attachment 3 may be required.

(b) In order to assess the impact of the equipment on the operation and performance of the distribution system or on other Users, the Network Service Provider may require a Generator to provide data on:
(1) power station and generating unit aggregate real and reactive power; and

(2) flicker coefficients and harmonic profile of the equipment, where applicable and especially for wind power and inverter connected equipment. Data on power quality characteristics, including flicker and harmonics, in accordance with IEC 61400-21 must be provided for all wind turbines.

(c) Net import / export data must be provided in the form of:

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

(2) details of the maximum kVA output over a 60 second interval, or such other form as specified in the relevant connection agreement.

(d) When requested by the Network Service Provider, a Generator must provide details of the proposed operation of the equipment during start-up, shut-down, normal daily operation, intermittent fuel or wind variations and under fault or emergency conditions.

(e) For generating units in a small power station of aggregate rating 5 MW and above, the Network Service Provider must assess the need for dynamic simulation studies and may require the Generator to provide a computer model in accordance with the requirements of clause 3.3.9.

3.6.4 Safety and Reliability

(a) The requirements imposed on a Generator by this clause 3.6 are intended to provide minimum safety and reliability standards for the distribution system and other Users. Subject to meeting these requirements, a Generator must design its facilities in accordance with applicable standards and regulations, good electricity industry practice and the manufacturers’ recommendations.

(b) The safety and reliability of the distribution system and the equipment of other Users are paramount and access applications must be evaluated accordingly. Generators must not connect or reconnect to the distribution system if the safety and reliability of the distribution system would be placed at risk.

(c) Where it is apparent that the operation of equipment installed in accordance with the requirements of this clause 3.6 may nevertheless have an adverse impact on the operation, safety or performance of the distribution system, or on the quality of supply to other Users, the Network Service Provider must consult with the User to reach an agreement on an acceptable solution. As a consequence, the Network Service Provider may require the Generator to test or modify its relevant equipment.
(d) Unless otherwise agreed in the relevant connection agreement, the Network Service Provider may require a Generator not to operate equipment in abnormal distribution system operating conditions.

(e) Equipment directly connected to the connection point of a small power station must be rated for the maximum fault current at the connection point specified in clause 2.5.8(b).

(f) A Generator must ensure that the maximum fault current contribution from a generating unit or small power station is not of a magnitude that will allow the total fault current at the connection point to exceed the levels specified in clause 2.5.8(b) for all distribution system operating conditions.

3.6.5 Requirements of clause 3.3 applicable to small power stations

Table 3.4 lists specific provisions of clause 3.3 that apply to small power stations in addition to the requirements of this clause 3.6.

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

<table>
<thead>
<tr>
<th>Clause</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3.3.1</td>
<td>Reactive power capability</td>
</tr>
<tr>
<td>3.3.3.3</td>
<td>Generating unit response to disturbances</td>
</tr>
<tr>
<td></td>
<td>Except that power stations with less than 150 kVA aggregate capacity need not comply with subclauses 3.3.3.3(c) and 3.3.3.3(g) unless directed otherwise by the Network Service Provider.</td>
</tr>
<tr>
<td>3.3.3.8</td>
<td>Protection of generating units from power system disturbances</td>
</tr>
<tr>
<td>3.3.4.4</td>
<td>Frequency control systems</td>
</tr>
<tr>
<td></td>
<td>Except that non-dispatchable induction generating units need not comply with subclauses (a), (b), (d) and (e)(2) and f(2); and</td>
</tr>
<tr>
<td></td>
<td>Except that non-synchronous power stations with less than 150 kVA aggregate capacity do not have to comply with subclauses (a), (b) and (d).</td>
</tr>
<tr>
<td>3.3.4.5</td>
<td>Voltage control systems</td>
</tr>
<tr>
<td></td>
<td>Except that non-synchronous generating units may be fitted with power factor control systems utilising modern technology, unless power system studies show that fast acting voltage and or reactive power control systems complying with clause 3.3.4.5(c) are required.</td>
</tr>
</tbody>
</table>
Subclause 3.3.4.5(e) does not apply; and

For power stations with a capacity of less than 150 kVA subclause 3.3.4.5(f) is replaced with:

*Generating units* must have *voltage control systems* that ensure that the requirements of clause 3.6.8 are met at the *connection point*.

### 3.6.6 Generating unit characteristics

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

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

### 3.6.7 Connection and Operation

#### 3.6.7.1 Generators' Substations

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

#### 3.6.7.2 Main Switch

(a) Each *facility* at which a *generating unit* in a small *power station is connected* to the *distribution system* must contain one main switch provided by the *User* for each *connection point* and one main switch for each *generating unit*, where a *generating unit* shares a *connection point* with other *generating units* or *loads*. For larger installations, additional *connection points* and main switches or a dedicated feeder may be required.

(b) Switches must be automatically operated, fault current breaking and making, ganged switches or circuit breakers. The relevant *facility* may also contain similarly rated interposed paralleling switches for the purpose of providing alternative synchronised switching operations.

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

Low voltage generating units with moulded case circuit breakers and fault limiting fuses with removable links are acceptable for isolation points in accordance with subclause 3.6.7.2(c).

3.6.7.3 Synchronising

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

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

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

3.6.7.4 Safe Shutdown without External Supply

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

3.6.8 Power Quality and Voltage Change

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

(b) The step voltage change at the connection point for connection and disconnection must comply with the requirements of clause 2.2.2.

These requirements may be achieved by synchronising individual generating units at intervals of at least two minutes.

On low voltage feeders, voltage changes up to 5% may be allowed in some circumstances with the approval of the Network Service Provider.

(c) The steady state voltage rise at the connection point resulting from export of power to the distribution system must not cause the voltage limits specified in clause 2.2 to be exceeded and, unless otherwise agreed with the Network Service Provider, must not exceed 2%.
3.6.8 The 2% limit on the voltage rise specified in this clause 3.6.8 (c) may be waived if the Generator is contracted by the Network Service Provider for the provision of voltage control services. Such a waiver is most likely to be necessary at fringe of grid locations.

3.6.9 Remote Control, Monitoring and Communications

(a) For generating units exporting 1 MVA or more to the distribution system the Generator must provide for:

(1) tripping of the generating unit remotely from the Network Service Provider’s control centre;

(2) a close-enable interlock operated from the Network Service Provider’s control centre; and

(3) remote monitoring at the control centre of (signed) MW, MVAr and voltage.

(b) For generating units exporting less than 1 MVA monitoring may not be required. However, where concerns for safety and reliability arise that are not adequately addressed by automatic protection systems and interlocks, the Network Services Provider may require the Generator to provide remote monitoring and remote control of some functions in accordance with clause 3.6.9(a).

(c) A Generator must provide a continuous communication link with the Network Service Provider’s control centre for monitoring and control for generating units exporting 1 MVA and above to the distribution system. For generating units exporting below 1 MVA, non-continuous monitoring and control may be required e.g. a bi-directional dial up arrangement.

(d) A Generator must have available at all times a telephone link or other communication channel to enable voice communications between a small power station and the Network Service Provider's control centre. For generating units exporting above 1 MVA, a back-up speech communication channel pursuant to clause 3.3.4.3(d) may be required.
3.6.10 Protection

This clause 3.6.10 applies only to protection necessary to maintain power system security. A Generator must design and specify any additional protection required to guard against risks within the Generator's facility.

3.6.10.1 General

(a) A Generator must provide, as a minimum, the protection functions specified in this clause 3.6.10 in accordance with the aggregate rated capacity of generating units in a small power station at the connection point.

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

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

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

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

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

Clause 1.9.3(b) specifies the process whereby the Rules may be changed to include alternatives to the standards currently specified.

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

(g) All small power stations must provide earth fault protection for earth faults on the distribution system. All small power stations connected at high voltage must have a sensitive earth fault protection scheme.
The earth fault protection scheme may be earth fault or neutral voltage displacement (depending on the earthing system arrangement).

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

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

(j) All small power stations must have loss of AC and DC auxiliary supply protection, which must immediately trip all switches that depend on that supply for operation of their protection, except where the auxiliary supply is duplicated in which case the failure may be alarmed in accordance with clause 3.6.12.

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

(l) Generating units that are only operated in parallel with the distribution system during rapid bumpless transfer must be protected by an independent timer that will disconnect the generating unit from the distribution system if the bumpless transfer is not successfully completed. Automatic transfer switches must comply with AS 60947.6.2 (2004). For the avoidance of doubt generating units covered by this clause need not comply with subclauses (f) to (k) of this clause 3.6.10.1.

The above exemption from subclauses (f) to (k) of clause 3.6.10.1 recognises that the rapid bumpless transfer will be completed or the generating unit will be disconnected by the disconnection timer before other protection schemes operate. Protection of the generating unit when it is not operating in parallel with the distribution system is at the discretion of the Generator.

3.6.10.2 Pole Slipping

Where it is determined that the disturbance resulting from loss of synchronism is likely to exceed that permitted in clause 2.2, the Generator must install a pole slipping protection scheme.

3.6.10.3 Islanding Protection

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

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

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

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

(d) Except as provided in clause 3.6.10.3(c) where a power station is rated at less than 1 MVA the two islanding protection schemes may be incorporated into the same multi-function protection relay, provided that the overcurrent and earth fault protection schemes required by clauses 3.6.10.1(f) and 3.6.10.1(g) are in a physically separate relay.

(e) Where there is no export of power into the distribution system and the aggregate rating of the power station is less than 150kVA, islanding protection schemes can be in the form of a directional power function that will operate for power export. Directional overcurrent relays may also be used for this purpose.

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

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

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

3.6.11 Intertripping

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

3.6.12 Failure of Generator’s Protection equipment

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

3.6.13 Commissioning and Testing

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

3.6.14 Technical matters to be coordinated

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

(1) design at connection point;
(2) physical layout adjacent to connection point;
(3) back-up (alternative) supply arrangements;
(4) protection and back-up;
(5) control characteristics;
(6) communications, metered quantities and alarms;
(7) insulation co-ordination and lightning protection;
(8) fault levels and fault clearing times;
(9) switching and isolation facilities;
(10) interlocking arrangements;
(11) synchronising facilities;
(12) under frequency load shedding and islanding schemes; and
(13) any special test requirements.

(b) As an alternative to distribution system augmentation, the Network Service Provider may require a Generator to provide additional protection schemes to ensure that operating limits and agreed import and export limits are not exceeded.
3.7 REQUIREMENTS FOR CONNECTION OF ENERGY SYSTEMS TO THE LOW VOLTAGE DISTRIBUTION SYSTEM VIA INVERTERS

3.7.1 Scope

(a) This clause 3.7 addresses the particular requirements for the connection of energy systems to the Network Service Provider’s low voltage distribution system via inverters. It covers installations rated up to 10 kVA single phase and 30 kVA three phase. For similarly rated non-inverter connected energy systems, the requirements of clause 3.6 apply.

(b) Nothing in this clause 3.7 obliges the Network Service Provider to approve the connection of an energy system to the low voltage distribution system if it considers that the power system performance standards specified in clause 2.2 will not be met as a consequence of the operation of the energy system.

The scope of this clause 3.7 is limited to technical conditions of connection. The Network Service Provider is not able to enter an energy buyback agreement directly. A User wishing to enter into such an agreement must apply to a participating retailer. It should also be noted that whereas this clause 3.7 covers connection issues for generators up to 30 kVA, the maximum generator capacity for which a retailer may be prepared to enter into an energy buyback agreement may be less than this amount.

3.7.2 Energy System Capacity, Imbalance and Assessment

(a) It is the responsibility of the Network Service Provider to carry out a connection assessment of the following inverter energy systems to confirm that the power system performance standards specified in clause 2.2 will be met when the inverter energy system is operating at its full rated capacity:

   (1) Single phase PV connections rated greater than 5kVA, and

   (2) 415 V three phase connections with more than 2.5kVA imbalance between any two phases.

(b) Notwithstanding clause 3.7.2(a), the Network Service Provider may carry out the assessment of connections below these thresholds if it deems necessary.

(c) The voltage rise across the service leads must not exceed 1% of the rated volts.

Typical remedial measures include upgrade of the service leads and/or splitting the generation across all three phases, where applicable.
3.7.3 Relevant Standards

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

(b) Inverter systems must satisfy the requirements of Australian Standard 4777-2005 “Grid connection of energy systems via inverters” as published and revised. The following parts of this standard apply:
   (1) AS 4777.1 – 2005 Part 1 Installation requirements.
   (2) AS 4777.2 – 2005 Part 2 Inverter requirements.
   (3) AS 4777.3 – 2005 Part 3 Grid protection requirements.

(c) The term 'inverter energy system' in these Rules has the same meaning as in AS 4777-2005.

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

(e) Inverter energy systems must be designed, installed and commissioned in accordance with good electricity industry practice and relevant Australian Standards.

(f) Should it be necessary to change any parameter of the equipment as installed and contracted, approval must be sought from Network Service Provider. Subsequently, the Network Service Provider will determine whether a revised application is required.

3.7.4 Metering Installation

The User must make provision for an import/export meter, as approved by the Network Service Provider.

3.7.5 Safety

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

All electrical installation, commissioning and maintenance work wherever required must be carried out by an electrical contractor licensed under the Electricity (Licensing) Regulations, 1991.

3.7.5.1 Labelling of switches

The User's installation must display warning labels in accordance with the WA Electrical Requirements. These labels must be maintained in good order.
3.7.5.2 **Security of operational settings**

Where operational settings are applied via a keypad or switches, adequate security must be employed to prevent tampering or inadvertent/unauthorised changes to these settings. A suitable lock or password system must be used. The *Network Service Provider* must approve changes to settings prior to implementation.

### 3.7.6 Circuit Arrangements

3.7.6.1 **Schematic diagram**

A durable single sided schematic-wiring diagram of the installation showing all *equipment* and switches must be affixed on the site adjacent to the inverter.

3.7.6.2 **Required switches**

All switches must be suitably rated for the required duty. Figure 3.7 provides an example schematic diagram for connection of an *energy* system via an inverter to the network. The modes of operation are detailed in Table 3.5.
Figure 3. 7 Schematic diagram for the connection of an inverter energy system

Table 3.5 Inverter energy system connection modes

<table>
<thead>
<tr>
<th>User’s Main Switch (CMS)</th>
<th>Inverter Supply Switch (ISS)</th>
<th>Operating Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>OFF</td>
<td>All power off</td>
</tr>
<tr>
<td>OFF</td>
<td>ON</td>
<td>Supply to the User from the inverter only</td>
</tr>
<tr>
<td>ON</td>
<td>OFF</td>
<td>Inverter isolated from the Western Power network</td>
</tr>
<tr>
<td>ON</td>
<td>ON</td>
<td>Inverter connected to the network</td>
</tr>
</tbody>
</table>
(a) **Main Switch**

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

(b) **Inverter Supply Switch**

A suitably rated inverter supply switch is required to isolate and protect the entire inverter energy system as shown in Figure 3.7. The inverter supply switch must be lockable in the OFF position.

It is preferable for the private generation source to be connected at the main switchboard. If this is not possible due to distance/cost considerations, the nearest sub board may be used.

(c) **Source Isolation Switch**

A Source Isolation Switch is required to isolate the energy source as shown in Figure 3.7. The source isolation switch must be rated for DC operation.

### 3.7.7 Protection

An inverter energy system connected to the distribution system must be approved by the Network Service Provider and meet the requirements of relevant standards in accordance with clause 3.7.3 and the following requirements below.

(a) The User must provide the information required by the Network Service Provider prior to approval being given.

(b) A User must maintain the integrity of the protection and control systems of the inverter energy system so that they comply with the requirements of these Rules, AS4777-2005 and the connection agreement at all times.

#### 3.7.7.1 Islanding protection

The islanding function must be automatic and must physically remove the inverter energy system from the distribution system. The islanding protection must be capable of detecting loss of supply from the network and disconnect the inverter energy system from the distribution system within 2 seconds.

#### 3.7.7.2 Synchronising

Connection to the distribution system must be automated. The protective apparatus must be capable of confirming that the supply voltage and frequency is within limits for no less than one minute prior to synchronisation.
3.7.7.3 **Reconnection to network**

Reconnection to the *distribution system* must be automated. The *protective apparatus* must be capable of confirming that the *supply voltage* and *frequency* are within limits for no less than one minute prior to *synchronisation*.

3.7.7.4 **Overcurrent protection**

Overcurrent *protection* must be provided at the inverter *energy system isolating switch* in accordance with the *equipment* rating unless otherwise agreed with the *Network Service Provider*.

3.7.7.5 **Voltage limits**

The inverter *voltage limits* must be set according to *equipment* capability and *AS 4777*. However the inverter *energy system* must remain *connected* for *voltage* variations within the limits of Table 3.6 unless otherwise agreed with the *Network Service Provider*. The network *voltage range* is based on 5-minute averages of the RMS value.

<table>
<thead>
<tr>
<th>Nominal voltage</th>
<th>Lower limit</th>
<th>Upper limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>240 V</td>
<td>226 V</td>
<td>254 V</td>
</tr>
<tr>
<td>415 V</td>
<td>390 V</td>
<td>440 V</td>
</tr>
</tbody>
</table>

Table 3.6 *Low Voltage Distribution System Voltage Limits*

3.7.7.6 **Frequency Limits**

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

3.7.8 **Commissioning and Testing**

3.7.8.1 **Exclusion of clause 4.2**

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

3.7.8.2 **Commissioning**

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

(b) In commissioning *equipment* installed under this clause 3.7, a *User* must verify that:
(1) The approved schematic has been checked and accurately reflects the installed electrical system.

(2) All required switches present and operate correctly as per the approved schematic.

(3) Signage and labelling comply with the *WA Electrical Requirements*.

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

(5) Operational settings are secure as specified.

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

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

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

3.7.8.3 Re-confirmation of correct operation

(a) The Network Service Provider may elect to inspect the proposed installation from time to time to ensure continued compliance with these requirements. In the event that the Network Service Provider considers that the installation poses a threat to safety, to quality of supply or to the integrity of the distribution system it may disconnect the generating equipment.

(b) To avoid doubt, clause 4.1.3 does not apply to generators covered by clause 3.7.

3.7.9 Signage

The User must provide signage as per the *WA Electrical Requirements*. 
4. INSPECTION, TESTING, COMMISSIONING, DISCONNECTION AND RECONNECTION

4.1 INSPECTION AND TESTING

4.1.1 Right of Entry and Inspection

(a) The Network Service Provider, System Management or any User whose equipment is connected directly to the transmission system and who is bound by these Rules (a reference to any of whom, for the purposes of this clause 4.1.1, includes its representatives) (in this clause 4.1.1 the "inspecting party") may, in accordance with this clause 4.1.1, enter and inspect any facility of the Network Service Provider or any User whose equipment is connected directly to the transmission system and who is bound by these Rules (in this clause 4.1.1 the "facility owner") and the operation and maintenance of that facility in order to:

1. assess compliance by the facility owner with its obligations under the Access Code or these Rules, or any relevant connection agreement;
2. investigate any operating incident in accordance with clause 5.7.3;
3. investigate any potential threat by that facility to power system security; or
4. conduct any periodic familiarisation or training associated with the operational requirements of the facility.

(b) If an inspecting party wishes to inspect a facility under clause 4.1.1(a), the inspecting party must give the facility owner at least:

1. 2 business days' notice or as otherwise agreed by the parties, or
2. 10 business days' notice for a non-urgent issue,

in writing of its intention to carry out an inspection.

(c) In the case of an emergency condition affecting the transmission or distribution system which the Network Service Provider or System Management reasonably considers requires access to a facility, prior notice to the facility owner is not required. However, the Network Service Provider or System Management, as applicable, must notify the facility owner as soon as practicable of the nature and extent of the activities it proposes to undertake, or which it has undertaken, at the facility.

(d) A notice given by an inspecting party under clause 4.1.1(b) must include the following information:

1. the name of the inspecting party's representative who will be conducting the inspection;
(2) the time when the inspection will commence and the expected time when the inspection will conclude; and

(3) the relevant reasons for the inspection.

(e) An inspecting party must not carry out an inspection under this clause 4.1.1 within 6 months of any previous inspection by it, except for the purpose of verifying the performance of corrective action claimed to have been carried out in respect of a non-conformance observed and documented on the previous inspection or, in the case of the Network Service Provider or System Management, for the purpose of investigating an operating incident in accordance with clause 5.7.3.

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

(1) not cause any damage to the facility;

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

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

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

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

(g) Any representative of an inspecting party conducting an inspection under this clause 4.1.1 must be appropriately qualified and experienced to perform the relevant inspection. If so requested by the facility owner, the inspecting party must procure that its representative (if not a direct employee of the inspecting party) enters into a confidentiality undertaking in favour of the facility owner in a form reasonably acceptable to the facility owner prior to seeking access to the relevant facility.
(h) An inspection under this clause 4.1.1(a) must not take longer than one day unless the inspecting party seeks approval from the facility owner for an extension of time (which approval must not be unreasonably withheld or delayed).

(i) Any equipment or goods installed or left on land or in premises of a facility owner after an inspection conducted under this clause 4.1.1 do not become the property of the facility owner (notwithstanding that they may be annexed or affixed to the land on which the facility is situated).

(j) In respect of any equipment or goods left by an inspecting party on land or in premises of a facility owner during or after an inspection, the facility owner must, and must procure that any person who owns or occupies the land on which the facility is situated or any part thereof does:

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

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

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

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

4.1.2 Right of Testing

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

(b) If a notice is given under clause 4.1.2(a), the relevant test must be conducted at a reasonable time mutually agreed by the requesting party and the equipment owner and, where the test may have an impact on the security of the power system, System Management or the Network Service Provider as the case requires. Such agreement must not be unreasonably withheld or delayed.

(c) An equipment owner who receives a notice under clause 4.1.2(a) must co-operate in relation to conducting the tests requested by that notice.

(d) Tests conducted in respect of a connection point under this clause 4.1.2 must be conducted using test procedures agreed between the Network Service Provider,
the relevant Users and, where appropriate, System Management, which agreement must not be unreasonably withheld or delayed.

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

(f) A requesting party may appoint a representative to witness the test requested by it under this clause 4.1.2 and the equipment owner must permit a representative so appointed to be present while the test is being conducted.

(g) Subject to clause 4.1.2(h), an equipment owner who conducts a test must submit a report to the requesting party and, where the test was one which could have had an impact on the security of the power system, System Management or the Network Service Provider as the case requires, within a reasonable period after the completion of the test. The report must outline relevant details of the tests conducted, including, but not limited to, the results of those tests.

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

(i) In carrying out monitoring under clause 4.1.2(i), the Network Service Provider must not cause the performance of the monitored equipment to be constrained in any way.

(j) If a test under this clause 4.1.2 or monitoring under clause 4.1.2(i) demonstrates that equipment does not comply with the Access Code, these Rules or the relevant connection agreement, then the equipment owner must:

1. promptly notify the requesting party of that fact;
2. promptly advise the requesting party of the remedial steps it proposes to take and the timetable for such remedial work;
3. diligently undertake such remedial work and report at monthly intervals to the requesting party on progress in implementing the remedial action; and
4. conduct further tests or monitoring on completion of the remedial work to confirm compliance with the relevant requirement.

4.1.3 Tests to Demonstrate Compliance with Connection Requirements for Generators

(a) (1) A Generator must provide evidence to the Network Service Provider that each of its generating units complies with the technical requirements of clause 3.3, or 3.6, as applicable, and the relevant connection agreement prior to commencing commercial operation. In
addition, each Generator must cooperate with the Network Service Provider and, if necessary, System Management in carrying out power system tests prior to commercial operation in order to verify the performance of each generating unit, and provide information and data necessary for computer model validation. The test requirements for synchronous generating units are detailed in Table A11.1 of Attachment 11. The Network Service Provider must specify test requirements for non-synchronous generation.

(2) Special tests may be specified by the Network Service Provider or System Management where reasonably necessary to confirm that the security and performance standards of the power system and the quality of service to other Users will not be adversely affected by the connection or operation of a Generator's equipment. The requirement for such tests must be determined on a case by case basis and the relevant Generator must be advised accordingly. Examples of these special tests are listed in Table A11.2 of Attachment 11. Where testing is not practicable in any particular case, the Network Service Provider may require the Generator to install recording equipment at appropriate locations in order to monitor equipment performance.

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

(4) A Generator must forward test procedures for undertaking the compliance tests required in respect of its equipment, including details of the recorders and measurement equipment to be used in the tests, to the Network Service Provider for approval 30 business days before the tests or as otherwise agreed. The Generator must provide all necessary recorders and other measurement equipment for the tests.

(5) A Generator must also coordinate the compliance tests in respect of its equipment and liaise with all parties involved, including the Network Service Provider and System Management. The Network Service Provider or System Management may witness the tests and must be given access to the site for this purpose, but responsibility for carrying out the tests remains with the Generator.
(6) All test results and associated relevant information including final transfer function block diagrams and settings of automatic voltage regulator, power system stabiliser, under excitation limiter and over excitation limiter must be forwarded to the Network Service Provider within 10 business days after the completion of the test.

(b) A Generator must negotiate in good faith with the Network Service Provider and agree on a compliance monitoring program, following commissioning, for each of its generating units to confirm ongoing compliance with the applicable technical requirements of clause 3.3, or 3.6, as applicable, and the relevant connection agreement. The negotiations must consider the use of high speed data recorders and similar non-invasive methods for verifying the equipment performance to the extent that such non-invasive methods are practicable.

(c) If compliance testing or monitoring of in-service performance demonstrates that a generating unit is not complying with one or more technical requirements of clause 3.3 and the relevant connection agreement then the Generator must:

(1) promptly notify the Network Service Provider and, where relevant, System Management of that fact;

(2) promptly advise the Network Service Provider and, where relevant, System Management of the remedial steps it proposes to take and the timetable for such remedial work;

(3) diligently undertake such remedial work and report at monthly intervals to the Network Service Provider on progress in implementing the remedial action; and

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

(d) If the Network Service Provider or, where relevant, System Management reasonably believes that a generating unit is not complying with one or more technical requirements of clause 3.3 or 3.6, as applicable, and the relevant connection agreement, the Network Service Provider or System Management may require the Generator to conduct tests within an agreed time to demonstrate that the relevant generating unit complies with those technical requirements and if the tests provide evidence that the relevant generating unit continues to comply with the technical requirement(s), whichever of the Network Service Provider or System Management that requested the test must reimburse the Generator for the reasonable expenses incurred as a direct result of conducting the tests.

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

(1) has reason to believe that a generating unit does not comply with one or more of the requirements of clause 3.3 or 3.6, as applicable;
(2) has reason to believe that a generating unit does not comply with the requirements for protection schemes set out in clause 2.9, as those requirements apply to the Generator under clause 3.5.1(b); or

(3) either:
   (A) does not have evidence demonstrating that a generating unit complies with the technical requirements set out in clause 3.3 or 3.6, as applicable; or
   (B) holds the opinion that there is, or could be, a threat to the power system security or stability,

the Network Service Provider or, where relevant, System Management, may direct the relevant Generator to operate the relevant generating unit at a particular generated output or in a particular mode of operation until the relevant Generator submits evidence reasonably satisfactory to the Network Service Provider or, where relevant, System Management, that the generating unit is complying with the relevant technical requirement. If such a direction is given orally, the direction, and the reasons for it, must be confirmed in writing to the Generator as soon as practicable after the direction is given.

(f) If:

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

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

then the Network Service Provider or System Management, as the case requires, may take such measures as are available to it (including, in the case of System Management, issuing an appropriate direction to the Network Service Provider to take measures) to cause the relevant generating unit to be operated at the required generated output or in the required mode, or disconnect the generating unit from the power system.

(g) A direction under clause 4.1.3(e) must be recorded by the Network Service Provider or System Management, as applicable.

(h) From the Rules commencement date, each Generator must maintain records and retain them for a minimum of 7 years (from the date of creation of each record) for each of its generating units and power stations setting out details of the results of all technical performance and monitoring conducted under this clause.
4.1.3 and make these records available to the Network Service Provider or System Management on request.

4.1.4 Routine Testing of Protection Equipment

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

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

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

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

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

(1) protection systems;

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

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

(4) control systems for load shedding.

(d) A compliance program under clause 4.1.4(c) must:

(1) include monitoring of the performance of the facilities;

(2) to the extent reasonably necessary, include provision of periodic testing of the performance of those facilities upon power system security depends;

(3) provide reasonable assurance of ongoing compliance of the power system with the performance standards specified in clause 2.2; and

(4) be in accordance with good electricity industry practice.
(e) The Network Service Provider and, where applicable, a User, must notify System Management immediately if it reasonably believes that a facility of the type listed in clause 4.1.4(c), and forming part of a registered facility, does not comply with, or is unlikely to comply with, relevant performance requirements specified in section 2.

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

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

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

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

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

1. could adversely affect the normal operation of the power system;
2. could cause a threat to power system security;
3. requires the power system to be operated in a particular way which differs from the way in which the power system is normally operated;
4. could affect the normal metering of energy at a connection point;
5. could threaten public safety; or
(6) could damage equipment at the connection point.

(d) If, in the Network Service Provider's opinion, a test could threaten public safety, damage or threaten to damage equipment or adversely affect the operation, performance or security of the power system, the Network Service Provider may direct that the proposed test procedure be modified or that the test not be conducted at the time proposed. Where appropriate, the Network Service Provider must consult with System Management in determining the nature of any modified test procedure or the appropriate time for the test to be conducted.

(e) The Network Service Provider must advise any other Users who will be adversely affected by a proposed test and consider any requirements of those Users when approving the proposed test.

(f) The User who conducts a test under this clause 4.1.5 must ensure that the person responsible for the coordination of the test promptly advises the Network Service Provider and, where appropriate, System Management, when the test is complete.

(g) If the Network Service Provider approves a proposed test, the Network Service Provider and, where appropriate, System Management must ensure that power system conditions reasonably required for that test are provided as close as is reasonably practicable to the proposed start time of the test and continue for the proposed duration of the test.

(h) Within a reasonable period after any such test has been conducted, the User who has conducted a test under this clause 4.1.5 must provide the Network Service Provider and, where appropriate, System Management, with a report in relation to that test, including test results where appropriate.

4.1.6 Tests of Generating units Requiring Changes to Agreed Operation

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

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

   (1) the tests must not be scheduled for a date earlier than 15 business days after notice is given by the Network Service Provider under clause 4.1.6(a);
(2) the Network Service Provider must ensure that the tests are conducted at the next scheduled outage of the relevant generating unit or at some other time which will minimise the departure from the commitment and dispatch that is anticipated to take place at that time; and

(3) in any event, the tests must be conducted no later than 9 months after notice is given by the Network Service Provider under clause 4.1.6(a).

(c) A Generator must provide any reasonable assistance requested by the Network Service Provider in relation to the conduct of the tests.

(d) Tests conducted under clause 4.1.6 must be conducted in accordance with test procedures agreed between the Network Service Provider and the relevant Generator. A Generator must not unreasonably withhold its agreement to test procedures proposed for this purpose by the Network Service Provider.

(e) The Network Service Provider must provide to a Generator such details of the analytic parameters of the model derived from the tests referred to in clause 4.1.6 for any of that Generator's generating units as may reasonably be requested by the Generator.

4.1.7 Power System Tests

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

(b) The tests described in clause 4.1.7(a) must be conducted, if considered necessary by the Network Service Provider or System Management, whenever:

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

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

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

(c) Tests as described in clause 4.1.7(a) may be requested by System Management or by a User. In either case, the Network Service Provider must conduct the tests unless it reasonably considers that the grounds for requesting the test are unreasonable.
(d) The *Network Service Provider* must notify all *Users* who could reasonably be expected to be affected by the proposed test at least 15 *business days* before any test under this clause 4.1.7 may proceed and consider any requirements of those *Users* when approving the proposed test.

(e) Operational conditions for each test must be arranged by the *Network Service Provider* in consultation, where relevant, with *System Management*, and the test procedures must be coordinated by an officer nominated by the *Network Service Provider* who has authority to stop the test or any part of it or vary the procedure within pre-approved guidelines if it considers any of these actions to be reasonably necessary.

(f) A *User* must cooperate with the *Network Service Provider* when required in planning and conducting *transmission and distribution system* tests as described in clause 4.1.7(a).

(g) The *Network Service Provider*, following consultation where appropriate with *System Management*, may direct the operation of *generating units* by *Users* during *power system* tests and, where necessary, the disconnection of *generating units* from the *transmission and distribution systems*, if this is necessary to achieve operational conditions on the *transmission and distribution systems* which are reasonably required to achieve valid test results.

(h) The *Network Service Provider* must plan the timing of tests so that the variation from *commitment* and *dispatch* that would otherwise occur is minimised and the duration of the tests is as short as possible consistent with test requirements and *power system security*.

### 4.2 COMMISSIONING OF *USER'S EQUIPMENT*

#### 4.2.1 Requirement to Inspect and Test *Equipment*

(a) A *User* must ensure that new or replacement *equipment* is inspected and tested to demonstrate that it complies with relevant *Australian Standards*, relevant international standards, these *Rules*, the *Access Code* and any relevant *connection agreement* and *good electricity industry practice* prior to being connected to a *transmission* or *distribution system*.

(b) If a *User* installs or replaces *equipment* at a *connection point*, the *Network Service Provider* is entitled to witness the inspections and tests described in clause 4.1.1(a).

#### 4.2.2 Co-ordination During Commissioning

(a) A *User* seeking to connect *equipment* to a *transmission* or *distribution system* must cooperate with the *Network Service Provider* to develop procedures to ensure that the commissioning of the *connection* and *connected facility* is carried out in a manner that:
(1) does not adversely affect other Users or affect power system security or quality of supply of the power system; and

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

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

(c) A User must not connect equipment to the network without the approval of the Network Service Provider who must not approve such connection before the User’s installation has been certified for compliance with these Rules and the WA Electrical Requirements. To avoid doubt, clause 4.2.2(c) does not apply if clause 3.7 applies.

4.2.3 Control and Protection Settings for Equipment

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

(b) The Network Service Provider must:

(1) consult with other Users and System Management 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 Service Provider's comments include alternative parameter settings for the new or replacement equipment, then the User must notify the Network Service Provider within 10 business days that it either accepts or disagrees with the alternative parameter settings suggested by the Network Service Provider.

(d) The Network Service Provider and the User must negotiate parameter settings that are acceptable to them both and if there is any unresolved disagreement between them, the matter must be determined by means of the disputes procedure provided for in clause 1.7.
(e) The User and the Network Service Provider must co-operate with each other to ensure that adequate grading of protection is achieved so that faults within the User's facility are cleared without adverse effects on the power system.

### 4.2.4 Commissioning Program

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

(b) The Network Service Provider must, within 20 business days of receipt of such advice under 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 Service Provider requires changes, then the Network Service Provider and the User must co-operate to reach agreement and finalise the commissioning program within a reasonable period.

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

### 4.2.5 Commissioning Tests

(a) The Network Service Provider and System Management have the right to witness commissioning tests relating to new or replacement equipment including remote monitoring equipment, protection and control and data acquisition equipment, that could reasonably be expected to alter materially the performance of the power system or the accurate metering of energy or be required for the real time operation of the power system.

(b) Prior to connection to the transmission or distribution system of new or replacement equipment covered by clause 4.2.5(a), a User must provide to the Network Service Provider a signed written statement to certify that the inspection and tests required under clause 4.2.1(a) have been completed and that the equipment is ready to be connected and energised. The statement must be certified by a Chartered Professional Engineer with National Professional Engineers’ Register Standing qualified in a relevant discipline.
(c) The Network Service Provider must, within a reasonable period of receiving advice of commissioning tests of a User's new or replacement equipment under this clause 4.2.5, advise the User whether or not it:

   (1) wishes to witness the commissioning tests; and

   (2) agrees with the proposed commissioning times.

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

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

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

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

4.2.6 Coordination of Protection Settings

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

(b) If a User seeks approval from the Network Service Provider to apply or change a control or protection system setting, this approval must not be withheld unless the Network Service Provider reasonably determines that the changed setting would cause the User not to comply with the requirements of clause 3 of these Rules, or the power system not to comply with the performance standards.
specified in clause 2.2, or the Network Service Provider or some other User not to comply with their own protection requirements specified in the respective clauses 2.9 and 3.5, or the power transfer capability of the transmission or distribution system to be reduced.

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

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

4.2.7 Approval of Proposed Protection

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

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

4.3 DISCONNECTION AND RECONNECTION

4.3.1 General

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

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

4.3.2 Voluntary Disconnection

(a) Unless agreed otherwise and specified in a connection agreement, a User must give to the Network Service Provider notice in writing of its intention to disconnect a facility permanently from a connection point.
(b) A User is entitled, subject to the terms of the relevant connection agreement, to require voluntary permanent disconnection of its equipment from the power system, in which case appropriate operating procedures necessary to ensure that the disconnection will not threaten power system security must be implemented in accordance with clause 4.3.3.

4.3.3 Decommissioning Procedures

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

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

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

4.3.4 Involuntary Disconnection

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

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

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

(3) in accordance with clause 4.3.5;

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

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

(6) in accordance with the provisions of any other Act or Regulation; or

(7) in accordance with the User's connection agreement.
Disconnection in accordance with clause 4.3.4(a)(5) could occur, for example, if the Network Service Provider becomes aware that a User’s earthing arrangements have been changed to the extent that they may no longer meet the requirements of clause 3.4.8(e).

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

4.3.5 Curtailment to Undertake Works

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

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

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

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

(4) if an event:

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

(B) whose effect on the assets of the Network Service Provider or the property of any person can not, by employing good electricity industry practice, be prevented, is imminent, with the result that safety requirements or the need to protect the assets of the Network Service Provider or any other property so require; or

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

(b) The Network Service Provider must keep the extent and duration of any curtailment under clause 4.3.5(a) to the minimum reasonably required in accordance with good electricity industry practice.
(c) The Network Service Provider must notify each User of the transmission system who will or may be adversely affected by any proposed curtailment under clause 4.3.5(a) of that proposed curtailment as soon as practicable. Where it is not reasonably practicable to notify a User prior to the commencement of the curtailment, the Network Service Provider must do so as soon as reasonably practicable after its commencement.

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

4.3.6 Disconnection During an Emergency

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

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

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

4.3.7 Obligation to Reconnect

The Network Service Provider or System Management must reconnect a User's facilities to a transmission or distribution transmission system as soon as practicable:

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

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

(c) if the User has taken all necessary steps to prevent the re-occurrence of the relevant breach and has delivered binding undertakings to the Network Service Provider or System Management, as applicable, that the breach will not re-occur.
5. **TRANSMISSION AND DISTRIBUTION SYSTEM OPERATION AND COORDINATION**

5.1 **APPLICATION**

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

5.2 **INTRODUCTION**

5.2.1 **Purpose and Scope of Section 5**

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

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

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

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

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

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

(a) take steps to coordinate *high voltage* switching procedures and arrangements in accordance with *good electricity industry practice* in order to avoid damage to *equipment* and to ensure the safety and *reliability* of the *power system*;

(b) operate all *equipment* and *equipment* under its control or co-ordination within the appropriate operational or emergency limits which are either established by the *Network Service Provider* or advised by the respective *Users*;

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

(d) subject to clause 5.3.2, to *disconnect User's equipment* as necessary during emergency situations to facilitate the re-establishment of the *normal operating state* in the *power system*;
coordinate and direct any rotation of supply interruptions in the event of a major supply shortfall or disruption; and

investigate and review all major transmission and distribution system and power system operational incidents and to initiate action plans to manage any abnormal situations or significant deficiencies which could reasonably threaten safe and reliable operation of the network. Such situations or deficiencies include:

1. power system frequencies outside those specified in the definition of normal operating state;
2. power system voltages outside those specified in the definition of normal operating state;
3. actual or potential power system instability; and
4. unplanned or unexpected operation of major power system equipment.

5.3.2 The Network Service Provider’s Obligations

(a) The Network Service Provider must, in accordance with the Access Code (including through the provision of appropriate information to Users to the extent permitted by law and under these Rules), to fulfil its transmission system or the distribution system operation and co-ordination responsibilities in accordance with the appropriate power system operating procedures and good electricity industry practice.

(b) The Network Service Provider must make accessible to Users such information as:

1. the Network Service Provider considers appropriate; and
2. the Network Service Provider is permitted to disclose,

in order to assist Users to make appropriate market decisions related to open access to the Network Service Provider’s transmission and distribution systems and, in doing so, the Network Service Provider must ensure that such information is available to those Users who request the information on a non-discriminatory basis.

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

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

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

(c) A User must co-operate with and assist the Network Service Provider or System Management in the proper discharge of the transmission or distribution system operation and co-ordination responsibilities.

(d) A User must operate its facilities and equipment in accordance with any direction given by the Network Service Provider or System Management.

(e) A User must notify System Management or, where appropriate, the Network Service Provider, prior to a generating unit being operated in a mode (e.g. "turbine-follow" mode) where the generating unit will be unable to respond in accordance with clause 3.3.4.4.

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

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

5.4 CONTROL OF TRANSMISSION SYSTEM VOLTAGES

5.4.1 Transmission and Distribution System Voltage Control

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

(b) The Network Service Provider must assess and determine the limits of the operation of the transmission and distribution system associated with the avoidance of voltage failure or collapse under contingency event scenarios. Any such determination must include a review of the voltage stability of the transmission system.

(c) The limits of operation of the transmission system must be translated by the Network Service Provider into key location operational voltage settings or limits, transmission line capacity limits, reactive power production (or absorption) capacity or other appropriate limits to enable their use by the System Management and, where appropriate, the Network Service Provider in the maintenance of power system security.
(d) The Network Service Provider must design and construct the transmission and distribution system such that voltage nominations at all connection points can be maintained in accordance with the technical requirements specified in section 2.

(e) In order to meet the requirements of clause 5.4.1(d), the Network Service Provider must arrange the provision of reactive power facilities and power system voltage stabilising facilities through:

1. contractual arrangements for ancillary services with appropriate Users;
2. obligations on the part of Users under relevant connection agreements; and
3. provision of such facilities by the Network Service Provider.

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

1. synchronous generating unit voltage controls usually associated with tap-changing transformers; or generating unit AVR set point control (rotor current adjustment);
2. synchronous condensers (compensators);
3. static VAr compensators (SVC);
4. static synchronous compensators (STATCOM);
5. shunt capacitors;
6. shunt reactors; and
7. series capacitors.

5.4.2 Reactive Power Reserve Requirements

The Network Service Provider must ensure that sufficient reactive power reserve is available at all times to maintain or restore the power system to a normal operating state after the most critical contingency event as determined by previous analysis or by periodic contingency analysis by the Network Service Provider.

5.4.3 Audit and Testing

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

5.5.1 Power System Fault Levels

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

(b) The fault levels determined under clause 5.5.1(a) must be publicly available. In addition, the Network Service Provider must ensure that there is available to a User, on request, such other information as will allow the User to determine the maximum fault level at any of the User's connection points.

5.5.2 Audit and Testing

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

5.5.3 Power Transfer Limits

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

5.5.4 Partial Outage of Power Protection systems

(a) Where there is an outage of one protection scheme of a transmission element, the Network Service Provider must determine, and where appropriate, advise System Management of, the most appropriate action to take to deal with that outage. Depending on the circumstances, the determination may be:

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

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

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

(4) to accept a degraded performance from the protection system, with or without additional operational measures or other temporary measures to minimise power system impact; or

(5) to operate the transmission element at a lower capacity.
(b) If there is an outage of both protections on a transmission element and the Network Service Provider determines that to leave the transmission element in service presents an unacceptable risk to power system security, the Network Service Provider must take the transmission element out of service as soon as practicable and advise System Management and any affected Users immediately this action is undertaken.

(c) The Network Service Provider must abide by any relevant instruction given to it by System Management in accordance the Market Rules.

(d) Any affected User must accept a determination made by the Network Service Provider under this clause 5.5.4.

5.6 **POWER SYSTEM STABILITY CO-ORDINATION**

5.6.1 **Stability Analysis Co-ordination**

The Network Service Provider must:

(a) ensure that all necessary calculations associated with the stable operation of the power system as described in clause 2.3.7 and used for the determination of settings of equipment used to maintain that stability are carried out; and

(b) coordinate those calculations and determinations.

5.6.2 **Audit and Testing**

The Network Service Provider must arrange, coordinate and supervise the conduct of such inspections and tests as it deems appropriate to assess the availability and adequacy of the devices installed to maintain power system stability.

5.7 **POWER SYSTEM SECURITY OPERATION AND CO-ORDINATION**

5.7.1 **User's Advice**

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

(b) If the Network Service Provider considers the circumstances advised to it under clause 5.7.1(a) to be a threat to power system security, the Network Service Provider, in consultation as necessary with System Management, may direct that the equipment protected or operated by the relevant protection or control system be taken out of operation or operated in such manner as the Network Service Provider requires.

(c) A User must comply with a direction given by the Network Service Provider under clause 5.7.1(b).
5.7.2 Managing Electricity Supply Shortfall Events

It is the responsibility of System Management under the Market Rules to manage supply shortfall events arising from a shortage of generation or from multiple contingency events on those parts of the transmission system under its direct control. However supply shortfall events may also occur as a result of contingency events arising within those parts of the transmission and distribution systems under the control of the Network Service Provider. In addition, the Network Service Provider may be required to manage the rotation of supply interruptions in accordance with clause 5.3.1(e).

(a) If, at any time, there are insufficient transmission or distribution supply options available to supply total load in a region securely, then the Network Service Provider may undertake any one or more of the following:

(1) recall of:

   (A) a distribution equipment outage;
   (B) a transmission equipment outage where the item of transmission equipment is not under the direct control of System Management;

(2) disconnect one or more load connection points as:

   (A) the Network Service Provider considers necessary; or
   (B) directed by System Management in accordance with the demand control measures in the Market Rules; or

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

(b) A User must comply with a direction given under clause 5.7.2(a)(3).

(c) If there is a major supply shortfall, the Network Service Provider must implement, to the extent practicable, load shedding across interconnected regions in the proportion and order set out in the operational plan established for that purpose under the Market Rules.

5.7.3 Review of Operating Incidents

(a) The Network Service Provider may conduct reviews of significant operating incidents or deviations from normal operating conditions in order to assess the adequacy of the provision and response of facilities or services, and must do so if directed by System Management.
(b) A User must co-operate in any such review conducted by the Network Service Provider (including by making available relevant records and information).

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

(d) For cases where the Network Service Provider or System Management has disconnected a transmission system User, a report must be provided by the Network Service Provider to the User detailing the circumstances that required the Network Service Provider or System Management to take that action.

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

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

5.8 OPERATIONS AND MAINTENANCE PLANNING

This clause is not intended to apply to Users who are registered as Rule Participants under Section 2 of the Market Rules. Outage planning for Rule Participants is undertaken by System Management in accordance with clauses 3.18 to 3.21 of the Market Rules.

In accordance with clause A3.56 of the Access Code, for coordination purposes, operation, maintenance and extension planning and co-ordination must be performed as follows:

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

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

(2) a non-binding indicative planned maintenance plan in respect of the equipment and equipment connected at each of its connection points for each of the 2 financial years following the financial year to which the maintenance schedule provided under clause 5.8(a)(1) relates.

(b) A User must provide the Network Service Provider with any information that the Network Service Provider requests concerning maintenance of equipment and equipment connected at the User's connection points.
(c) A User must ensure that a maintenance schedule provided by the User under clause 5.8(a)(1) is complied with, unless otherwise agreed with the Network Service Provider.

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

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

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

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

(4) be consistent with good electricity industry practice.

(e) If a User becomes aware that a maintenance schedule provided by the User under clause 5.8(a)(1) in respect of one of its connection points will not be complied with, then the User must promptly notify the Network Service Provider.

5.9 POWER SYSTEM OPERATING PROCEDURES

5.9.1 Operation of User's Equipment

(a) A User must observe the requirements of the relevant power system operating procedures.

(b) A User must operate its equipment interfacing with the transmission or distribution system in accordance with the requirements of the Access Code, these Rules, any applicable connection agreement, and the Network Service Provider’s Electrical Safety Instructions and procedures.

(c) The Network Service Provider may direct a User to place reactive power facilities belonging to, or controlled by, that User into or out of service for the purposes of maintaining power system performance standards specified in clause 2.2. A User must comply with any such direction.

5.10 POWER SYSTEM OPERATION SUPPORT

5.10.1 Remote Control and Monitoring Devices

(a) All remote control, operational metering and monitoring devices and local circuits as described in section 3 must be installed, operated and maintained by a User in accordance with the standards and protocols determined and advised by the Network Service Provider or System Management.
5.10.2 **Power System Operational Communication Facilities**

(a) *Users* must advise the *Network Service Provider* of its requirements for the giving and receiving of *operational communications* in relation to each of its *facilities*. The requirements which must be forwarded to the *Network Service Provider* include:

1. the title of contact position;
2. the telephone numbers of that position;
3. the telephone numbers of other available communication systems in relation to the relevant *facility*;
4. a facsimile number for the relevant *facility*; and
5. an electronic mail address for the relevant *facility*.

(b) A *User* must maintain the speech communication channel installed in accordance with clause 3.3.4.3(c) or clause 3.6.9(d) in good repair and must investigate any fault within 4 hours, or as otherwise agreed with the *Network Service Provider*, of that fault being identified and must repair or procure the repair of faults promptly.

(c) Where required by *System Management* or the *Network Service Provider* a *User* must establish and maintain a form of electronic mail *facility* as approved by the *Network Service Provider* for communication purposes.

(d) The *Network Service Provider* must, where necessary for the operation of the *transmission and distribution system*, advise *Users* of nominated persons for the purposes of giving or receiving *operational communications*.

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

5.10.3 **Authority of Nominated Operational Contacts**

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

5.10.4 **Records of Power System Operational Communication**

(a) The *Network Service Provider* and *Users* must log each telephone *operational communication* in the form of entries in a log book which provides a permanent record as soon as practicable after making or receiving the *operational communication*. 
(b) In addition to the log book entry required under clause 5.10.4(a), the Network Service Provider must make a voice recording of each telephone operational communication. The Network Service Provider must ensure that when a telephone conversation is being recorded under this clause 5.10.4(b), the persons having the conversation receive an audible indication that the conversation is being recorded in accordance with relevant statutory requirements.

(c) Records of operational communications must include the time and content of each communication and must identify the parties to each communication.

(d) The Network Service Provider and Users must retain all operational communications records including voice recordings for a minimum of 7 years.

(e) If there is a dispute involving an operational communication, the voice recordings of that operational communication maintained by, or on behalf of the Network Service Provider will constitute prima facie evidence of the contents of the operational communication.

5.11 NOMENCLATURE STANDARDS

(a) A User must use the nomenclature standards for transmission and distribution equipment and apparatus as determined by the Network Service Provider, and use the agreed nomenclature in any operational communications with the Network Service Provider.

(b) A User must ensure that name plates on its equipment relevant to operations at any point within the power system conform to the agreed nomenclature and are maintained to ensure easy and accurate identification of equipment.

(c) A User must ensure that technical drawings and documentation provided to the Network Service Provider comply with the agreed nomenclature.

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

(a) a word or phrase set out in column 1 of the table below has the meaning set out opposite that word or phrase in column 2 of that table; and

(b) a word or phrase defined in the *Act* or the *Access Code* has the meaning given in that *Act* or that Code (as the case requires), unless redefined in the table below.

<table>
<thead>
<tr>
<th>abnormal equipment conditions</th>
<th>Are, for the purpose of clause 2.9, those conditions that prevail at a particular location in the <em>power system</em> when the following circumstances exist:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(a) the number of <em>generating units connected</em> to the <em>power system</em> is the least number normally <em>connected</em> at times of minimum <em>generation</em>;</td>
</tr>
<tr>
<td></td>
<td>(b) there is one worst case <em>generating unit outage</em>; and</td>
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<tr>
<td></td>
<td>(c) there are either</td>
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<tr>
<td></td>
<td>(1) no more than two primary <em>equipment outages</em>; or</td>
</tr>
<tr>
<td></td>
<td>(2) no more than one primary <em>equipment outage</em> and no more than one secondary <em>equipment outage</em>.</td>
</tr>
<tr>
<td></td>
<td>where the primary <em>equipment outage(s)</em> are those which, in combination with the other circumstances of the kind listed in paragraphs (a) to (c) of this definition then existing, lead to the lowest fault current at the particular location, or to the maximum reduction in <em>sensitivity</em> of the remaining secondary system for the fault type under consideration, or to both.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>access arrangement</th>
<th>The meaning given in the <em>Access Code</em>.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Code</td>
<td>The <em>Electricity Networks Access Code 2004 (WA)</em></td>
</tr>
<tr>
<td>access contract</td>
<td>The meaning given in the <em>Act</em>.</td>
</tr>
<tr>
<td>access application</td>
<td>The meaning given in the <em>Access Code</em>.</td>
</tr>
<tr>
<td>access services</td>
<td>The same meaning as &quot;covered service&quot; in the <em>Access Code</em>.</td>
</tr>
<tr>
<td>accumulated synchronous time error</td>
<td>The difference between Western Australia Standard Time and the time measured by integrating the instantaneous operating <em>frequency</em> of the <em>power system</em>.</td>
</tr>
<tr>
<td><strong>Act</strong></td>
<td>The <em>Electricity Industry Act 2004</em> (WA).</td>
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<td>----------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td><strong>active energy</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>active power</strong></td>
<td>The rate at which active energy is transferred.</td>
</tr>
<tr>
<td><strong>active power capability</strong></td>
<td>The maximum rate at which active energy may be transferred from a generating unit to a connection point as specified in the relevant connection agreement.</td>
</tr>
<tr>
<td><strong>agreed capability</strong></td>
<td>In relation to a connection point, the capability to receive or send out active power and reactive power for that connection point determined in accordance with the relevant connection agreement.</td>
</tr>
<tr>
<td><strong>ancillary service(s)</strong></td>
<td>The same meaning as &quot;covered service(s)&quot; in the Access Code.</td>
</tr>
<tr>
<td><strong>apparent power</strong></td>
<td>The positive square root of the sum of the squares of the active power and the reactive power.</td>
</tr>
<tr>
<td><strong>applicant</strong></td>
<td>The meaning given in the Access Code.</td>
</tr>
<tr>
<td><strong>augment, augmentation</strong></td>
<td>The meaning given in the Access Code.</td>
</tr>
<tr>
<td><strong>Australian Standard (AS)</strong></td>
<td>The edition of a standard publication by Standards Australia (Standards Association of Australia) as at the date specified in the relevant clause or, where no date is specified, the most recent edition.</td>
</tr>
<tr>
<td><strong>Authority</strong></td>
<td>Means the Economic Regulation Authority established under the <em>Economic Regulation Authority Act 2003</em> (WA).</td>
</tr>
<tr>
<td><strong>automatic reclose equipment</strong></td>
<td>In relation to a transmission line, the equipment which automatically recloses the relevant line's circuit breaker(s) following their opening as a result of the detection of a fault in the transmission line.</td>
</tr>
<tr>
<td><strong>back-up protection system</strong></td>
<td>A protection system intended to supplement the main protection system in case the latter does not operate correctly, or to deal with faults in those parts of the power system that are not readily included in the operating zone of the main protection system. A back-up protection system may use the same circuit breakers as a main protection system and a protection scheme forming part of a backup protection system may be incorporated in the same protection apparatus as the protection schemes comprising the main protection system.</td>
</tr>
<tr>
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<tr>
<td><strong>black start-up equipment</strong></td>
<td>The equipment required to provide a generating unit with the ability to start and synchronise without using electricity supplied from the power system.</td>
</tr>
<tr>
<td><strong>busbar</strong></td>
<td>A common connection point in a power station substation or a transmission or distribution system substation.</td>
</tr>
<tr>
<td><strong>business day</strong></td>
<td>The meaning given in the Access Code.</td>
</tr>
<tr>
<td><strong>capacitor bank</strong></td>
<td>A type of electrical equipment used to generate reactive power and therefore support voltage levels on transmission or distribution lines.</td>
</tr>
<tr>
<td><strong>cascading outage</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>change</strong></td>
<td>Includes amendment, alteration, addition or deletion.</td>
</tr>
<tr>
<td><strong>circuit breaker failure</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>commitment</strong></td>
<td>The commencement of the process of starting up and synchronising a generating unit to the power system.</td>
</tr>
<tr>
<td><strong>connected</strong></td>
<td>The state of physical linkage to or through the transmission or distribution system, by direct or indirect connection, so as to have an impact on power system security, reliability and quality of supply.</td>
</tr>
<tr>
<td><strong>connection agreement</strong></td>
<td>An agreement or other arrangement between the Network Service Provider and a User, which may form part of or include an access contract, that specifies the technical requirements that apply in relation to the connection of a User’s equipment to the transmission or distribution system.</td>
</tr>
<tr>
<td><strong>connection asset</strong></td>
<td>The <em>equipment</em> that allows the transfer of electricity between the electricity <em>transmission</em> or <em>distribution system</em> and an electrical system that is not part of that <em>transmission</em> or <em>distribution system</em>. This includes any <em>transformers</em> or switchgear at the point of <em>interconnection</em> (including those that operate at a nominal <em>voltage</em> of less than 66 kV) but does not include the lines and switchgear at the <em>connection point</em> that form part of the electricity <em>transmission</em> or <em>distribution system</em>.</td>
</tr>
<tr>
<td><strong>connection point</strong></td>
<td>The agreed point of <em>supply</em> established between the <em>Network Service Provider</em> and a <em>User</em>.</td>
</tr>
<tr>
<td><strong>constant P &amp; Q loads</strong></td>
<td>A particular type of <em>load</em> model which does not change its respective MW and MVAr consumption as the system <em>voltage</em> or <em>frequency</em> varies.</td>
</tr>
<tr>
<td><strong>constraint</strong></td>
<td>A limitation on the capability of a <em>transmission</em> or <em>distribution system</em>, <em>load</em> or a <em>generating unit</em> preventing it from either transferring, consuming or generating the level of electric power which would otherwise be available if the limitation was removed.</td>
</tr>
<tr>
<td><strong>Consumer</strong></td>
<td>A <em>User</em> who consumes electricity supplied through a <em>connection point</em>.</td>
</tr>
<tr>
<td><strong>contingency event</strong></td>
<td>An event affecting the <em>power system</em> which the <em>Network Service Provider</em> expects would be likely to involve the failure or removal from operational service of a <em>generating unit</em> or <em>transmission/distribution element</em>.</td>
</tr>
<tr>
<td><strong>control centre</strong></td>
<td>A <em>facility</em> used by the <em>System Management</em> or <em>Network Service Provider</em> for directing the minute to minute operation of the <em>power system</em>.</td>
</tr>
<tr>
<td><strong>controllable</strong></td>
<td>For the purpose of clause 2.2.11, means that <em>voltages</em> at all major <em>busbars</em> in the <em>transmission and distribution system</em> must be able to be maintained continuously at the target level notwithstanding variations in <em>load</em> or that some <em>reactive</em> sources may have reached their output limits in the post-fault steady state.</td>
</tr>
<tr>
<td><strong>controller</strong></td>
<td>The same meaning as &quot;designated controller&quot; in Appendix 3 of the <em>Access Code</em>.</td>
</tr>
<tr>
<td><strong>control system</strong></td>
<td>The means of monitoring and controlling the operation of the <em>power system</em> or <em>equipment</em> including generating units connected to a <em>transmission</em> or <em>distribution system</em>.</td>
</tr>
<tr>
<td><strong>converter coupled generating unit</strong></td>
<td>A generating unit that uses equipment that changes the alternating-current power produced by the generating unit to alternating-current power acceptable for transfer to the power system at a connection point.</td>
</tr>
</tbody>
</table>
| **credible contingency event** | A single contingency event of one of the following types:  
   (a) A three-phase to earth fault cleared by disconnection of the faulted component, with the fastest main protection scheme out of service;  
   (b) a single-phase to earth fault cleared by the disconnection of the faulted component, with the fastest main protection scheme out of service;  
   (c) a single-phase to earth fault cleared after unsuccessful high-speed single-phase auto-reclosure onto a persistent fault;  
   (d) a single-phase to earth small zone fault or a single-phase to earth fault followed by a circuit breaker failure, in either case cleared by the operation of the fastest available protection scheme; or  
   (e) a sudden disconnection of a system component, e.g. a transmission line or a generation unit. |
| **critical fault clearance time** | The maximum total fault clearance time that the power system can withstand without one or both of the following conditions arising:  
   (a) instability; and  
   (b) unacceptable disturbance of power system voltage or frequency. |
<p>| <strong>current rating</strong> | The maximum current that may be permitted to flow (under defined conditions) through a transmission or distribution line or other item of equipment that forms part of a power system. |
| <strong>current transformer (CT)</strong> | A transformer for use with meters or protection devices or both in which the current in the secondary winding is, within prescribed error limits, proportional to and in phase with the current in the primary winding. |</p>
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>damping ratio</td>
<td>A standard mathematical parameter that characterises the shape of a damped sine wave.</td>
</tr>
<tr>
<td>decommission</td>
<td>The act of causing a generating unit to cease to generating indefinitely and disconnecting it from a transmission or distribution system.</td>
</tr>
<tr>
<td>direction</td>
<td>A requirement issued by the Network Service Provider or System Management to any User requiring the User to do any act or thing which the Network Service Provider or System Management considers necessary to maintain or re-establish power system security or to maintain or re-establish the power system in a reliable operating state in accordance with these Rules.</td>
</tr>
<tr>
<td>disconnect</td>
<td>The operation of switching equipment or other action so as to prevent the flow of electricity at a connection point.</td>
</tr>
<tr>
<td>dispatchable generating unit</td>
<td>A generating unit that, in its satisfactory normal operating state, is capable of closely controlling its real power output.</td>
</tr>
<tr>
<td>dispatch</td>
<td>The act of the Network Service Provider in committing to service all or part of the generation available from a generating unit.</td>
</tr>
<tr>
<td>distribution</td>
<td>The functions performed by a distribution system, including conveying, transferring or permitting the passage of electricity.</td>
</tr>
<tr>
<td>distribution feeder</td>
<td>A high voltage radial circuit forming part of the distribution system that is supplied from a zone substation.</td>
</tr>
<tr>
<td>distribution system</td>
<td>Any apparatus, equipment, plant or buildings used, or to be used, for, or in connection with, the transportation of electricity at nominal voltages of less than 66 kV and which form part of the South West Interconnected Network.</td>
</tr>
<tr>
<td>dynamic performance</td>
<td>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.</td>
</tr>
<tr>
<td>embedded generating unit</td>
<td>A generating unit which supplies on-site loads or distribution system loads and is connected either indirectly (i.e. by means of the distribution system) or directly to the transmission system.</td>
</tr>
<tr>
<td>emergency conditions</td>
<td>The operating conditions applying after a significant transmission system element has been removed from service other than in a planned manner.</td>
</tr>
<tr>
<td><strong>energisation</strong></td>
<td>The act or process of operating switching <em>equipment</em> or starting up <em>generating unit</em>, which results in there being a non-zero <em>voltage</em> beyond a <em>connection point</em> or part of the <em>transmission system</em> or the <em>distribution system</em>.</td>
</tr>
<tr>
<td><strong>energy</strong></td>
<td>Active <em>energy</em> or reactive <em>energy</em>, or both.</td>
</tr>
<tr>
<td><strong>equipment</strong></td>
<td>A device used in generating, transmitting or utilising electrical <em>energy</em> or making available electric power.</td>
</tr>
<tr>
<td><strong>essential services</strong></td>
<td><em>Essential services</em> include, but are not necessarily limited to, services such as hospitals and railways where the maintenance of a supply of electricity is necessary for the maintenance of public health, order and safety.</td>
</tr>
<tr>
<td><strong>excitation control system</strong></td>
<td>In relation to a <em>generating unit</em>, the automatic <em>control system</em> that provides the field excitation for the <em>generating unit</em> of the <em>generating unit</em> (including excitation limiting devices and any <em>power system</em> stabiliser).</td>
</tr>
<tr>
<td><strong>extension</strong></td>
<td>An <em>augmentation</em> that requires the connection of a power line or <em>facility</em> to the <em>transmission</em> or <em>distribution system</em>.</td>
</tr>
<tr>
<td><strong>facility</strong></td>
<td>An installation comprising <em>equipment</em> and associated apparatus, buildings and necessary associated supporting resources used for or in connection with generating, conveying, transferring or consuming electricity, and includes:</td>
</tr>
<tr>
<td></td>
<td>(a) a <em>power station</em>;</td>
</tr>
<tr>
<td></td>
<td>(b) a <em>substation</em>;</td>
</tr>
<tr>
<td></td>
<td>(c) <em>equipment</em> by which electricity is consumed; and</td>
</tr>
<tr>
<td></td>
<td>(d) a <em>control centre</em>.</td>
</tr>
<tr>
<td><strong>fault clearance time</strong></td>
<td>The time interval between the occurrence of a fault and the fault clearance.</td>
</tr>
<tr>
<td><strong>financial year</strong></td>
<td>A period or 12 <em>months</em> commencing on 1 July.</td>
</tr>
<tr>
<td><strong>frequency</strong></td>
<td>For alternating current electricity, the number of cycles occurring in each second, measured in Hz.</td>
</tr>
<tr>
<td><strong>frequency operating standards</strong></td>
<td>The standards which specify the <em>frequency</em> levels for the operation of the <em>power system</em> set out in clause 2.2.</td>
</tr>
<tr>
<td>Glossary Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>frequency stability</td>
<td>The ability of a power system to attain a steady frequency following a severe system disturbance that has resulted in a severe imbalance between generation and load. Instability that may result occurs in the form of sustained frequency swings leading to tripping of generating units or loads or both.</td>
</tr>
<tr>
<td>generated</td>
<td>In relation to a generating unit, the amount of electricity produced by the generating unit as measured at its terminals.</td>
</tr>
<tr>
<td>generating equipment</td>
<td>In relation to a connection point, includes all equipment involved in generating electrical energy transferred at that connection point.</td>
</tr>
<tr>
<td>generating system</td>
<td>A system comprising one or more generating units.</td>
</tr>
<tr>
<td>generating unit</td>
<td>The equipment used to generate electricity and all the related equipment essential to its functioning as a single entity.</td>
</tr>
<tr>
<td>generation</td>
<td>The production of electric power by converting another form of energy into electricity in a generating unit.</td>
</tr>
<tr>
<td>Generator</td>
<td>Any person (including a User or the Network Service Provider) who owns, controls or operates a generating system that supplies electricity to, or who otherwise supplies electricity to, the transmission system or distribution system.</td>
</tr>
<tr>
<td>generator machine</td>
<td>The machine used for the generation of electricity, excluding related or auxiliary equipment.</td>
</tr>
<tr>
<td>good electricity industry practice</td>
<td>The meaning given in the Access Code.</td>
</tr>
<tr>
<td>gradual bumpless transfer</td>
<td>The make-before-break transfer of a load between the distribution system and an islanded generating unit (or vice versa) where the time for which the generating unit is operated in parallel with the distribution system is limited to less than 60 seconds.</td>
</tr>
<tr>
<td>halving time</td>
<td>The elapsed time required for the magnitude of a damped sine wave to reach half its initial value.</td>
</tr>
<tr>
<td>high voltage</td>
<td>Any nominal voltage above 1 kV.</td>
</tr>
<tr>
<td>Independent Market Operator</td>
<td>The entity authorised under the Electricity Industry (Wholesale Electricity Market) Regulations 2004 (WA) to administer and operate the Western Australia Wholesale Electricity Market.</td>
</tr>
<tr>
<td>Glossary Term</td>
<td>Definition</td>
</tr>
<tr>
<td>---------------</td>
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</tr>
<tr>
<td><strong>induction generating unit</strong></td>
<td>An alternating current generating unit whose rotor currents are produced by induction from its stator windings and, when driven above synchronous speed by an external source of mechanical power, converts mechanical power to electric power by means of a conventional induction machine.</td>
</tr>
<tr>
<td><strong>interconnection</strong></td>
<td>A transmission line or group of transmission lines that connects the transmission systems in adjacent regions.</td>
</tr>
<tr>
<td><strong>inverter coupled generating unit</strong></td>
<td>A generating unit which uses a machine, device, or system that changes its direct-current power to alternating-current power acceptable for power system connection.</td>
</tr>
<tr>
<td><strong>large disturbance</strong></td>
<td>A disturbance sufficiently large or severe as to prevent the linearization of system equations for the purposes of analysis. The resulting system response involves large excursions of system variables from their pre-disturbance values, and is influenced by non-linear power-angle relationship and other non-linearity effects in power systems. Large disturbance is typically caused by a short circuit on a nearby power system component (for example, transmission line, transformer, etc.).</td>
</tr>
<tr>
<td><strong>load</strong></td>
<td>Either: (a) a connection point at which electric power is made available to a person; or (b) the amount of electric power transfer at a defined instant at a specified point on the transmission or distribution system as the case requires.</td>
</tr>
<tr>
<td><strong>load shedding</strong></td>
<td>Reducing or disconnecting load from the power system.</td>
</tr>
<tr>
<td><strong>low voltage</strong></td>
<td>Any nominal voltage of 1 kV and below</td>
</tr>
<tr>
<td><strong>main protection scheme</strong></td>
<td>A protection scheme that has the primary purpose of disconnecting specific equipment from the transmission and distribution system in the event of a fault occurring within that equipment.</td>
</tr>
<tr>
<td><strong>main protection system</strong></td>
<td>A protection system that has the primary purpose of disconnecting specific equipment from the transmission and distribution system in the event of a fault occurring within that equipment.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>maintenance conditions</td>
<td>The operating conditions that exist when a significant element of the transmission system or the distribution system has been taken out of service in a planned manner so that maintenance can be carried out safely.</td>
</tr>
<tr>
<td>maximum fault current</td>
<td>The current that will flow to a fault on an item of equipment when maximum system conditions prevail.</td>
</tr>
<tr>
<td>maximum system conditions</td>
<td>For any particular location in the power system, those conditions that prevail when the maximum number of generating units that are normally connected at times of maximum generation are so connected.</td>
</tr>
<tr>
<td>minimum fault current</td>
<td>The current that will flow to a fault on an item of equipment when minimum system conditions prevail.</td>
</tr>
<tr>
<td>minimum system conditions</td>
<td>For any particular location in the power system, those conditions that prevail when:</td>
</tr>
<tr>
<td></td>
<td>(a) the least number of generating units normally connected at times of minimum generation are so connected; and</td>
</tr>
<tr>
<td></td>
<td>(b) there is one primary equipment outage.</td>
</tr>
<tr>
<td></td>
<td>The primary equipment outage is taken to be that which, in combination with the minimum generation, leads to the lowest fault current at the particular location for the fault type under consideration.</td>
</tr>
<tr>
<td>monitoring equipment</td>
<td>The testing instruments and devices used to record the performance of equipment for comparison with expected performance.</td>
</tr>
<tr>
<td>month</td>
<td>The meaning given to it in section 62 of the Interpretation Act 1984 (WA).</td>
</tr>
<tr>
<td>nameplate rating</td>
<td>The maximum continuous output or consumption specified either in units of active power (watts) or apparent power (volt-amperes) of an item of equipment as specified by the manufacturer.</td>
</tr>
<tr>
<td>Network Service Provider</td>
<td>The meaning given to it in clause 1.3(a).</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>new capacity</td>
<td>Any increase in electricity generation, transmission or distribution capacity which would arise from enhancement to or expansion of the electricity generation, transmission system or distribution system.</td>
</tr>
<tr>
<td>nomenclature standards</td>
<td>The standards approved by the Network Service Provider relating to numbering, terminology and abbreviations used for information transfer between Users as provided for in clause 5.11.</td>
</tr>
<tr>
<td>non-dispatchable generating unit</td>
<td>A generating unit that in its satisfactory normal operating state is not capable of closely controlling its real power output.</td>
</tr>
<tr>
<td>non-synchronous generating unit</td>
<td>Any generating unit other than a directly connected synchronous generating unit</td>
</tr>
<tr>
<td>normal operating state</td>
<td>Characterises operation when all significant elements of a transmission system are in service and operation is within the secure technical envelope.</td>
</tr>
<tr>
<td>operational communication</td>
<td>A communication concerning the arrangements for, or actual operation of, the power system in accordance with the Rules.</td>
</tr>
<tr>
<td>operator</td>
<td>The person or organisation responsible for the provision of service in real time.</td>
</tr>
<tr>
<td>outage</td>
<td>Any planned or unplanned full or partial unavailability of equipment.</td>
</tr>
<tr>
<td>peak load</td>
<td>Maximum load.</td>
</tr>
<tr>
<td>Perth CBD</td>
<td>The geographical area in the City of Perth bound by Hill Street (East), Havelock Street (West), Wellington Street (North) and Riverside Drive and Kings Park Road (South) and supplied (exclusively or in part) from the following zone substations: Hay Street, Milligan Street, Wellington Street, Cook Street and Forrest Avenue(1).</td>
</tr>
<tr>
<td>(1) Subject to a periodic review</td>
<td></td>
</tr>
<tr>
<td>power factor</td>
<td>The ratio of the active power to the apparent power at a point.</td>
</tr>
<tr>
<td>power station</td>
<td>The one or more generating units at a particular location and the apparatus, equipment, buildings and necessary associated supporting resources for those generating units, including black start-up equipment, step-up transformers, substations and the power station control centre.</td>
</tr>
<tr>
<td><strong>power system</strong></td>
<td>The electric power system constituted by the South West Interconnected Network and its connected generation and loads, operated as an integrated system.</td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>power system operating procedures</strong></td>
<td>The procedures to be followed by Users in carrying out operations and maintenance activities on or in relation to primary equipment and secondary equipment connected to or forming part of the power system or connection points, as described in clause 5.9.1.</td>
</tr>
<tr>
<td><strong>power system security</strong></td>
<td>The safe scheduling, operation and control of the power system on a continuous basis in accordance with the principles set out in clause 5 and the operating procedures of the Network Service Provider or System Management.</td>
</tr>
<tr>
<td><strong>power system stability</strong></td>
<td>The ability of an electric power system, for a given initial operating condition, to regain a state of operating equilibrium after being subjected to a physical disturbance, with most system variables bounded so that practically the entire system remains intact.</td>
</tr>
<tr>
<td><strong>power transfer</strong></td>
<td>The instantaneous rate at which active energy is transferred between connection points.</td>
</tr>
<tr>
<td><strong>power transfer capability</strong></td>
<td>The maximum permitted power transfer through a transmission or distribution system or part thereof.</td>
</tr>
<tr>
<td><strong>primary equipment</strong></td>
<td>Refers to apparatus which conducts power system load or conveys power system voltage.</td>
</tr>
<tr>
<td><strong>protection</strong></td>
<td>The detection, limiting and removal of the effects of primary equipment faults from the power system; or the apparatus, device or system required to achieve this function.</td>
</tr>
<tr>
<td><strong>protection apparatus</strong></td>
<td>Includes all relays, meters, power circuit breakers, synchronisers and other control devices necessary for the proper and safe operation of the power system.</td>
</tr>
<tr>
<td><strong>protection scheme</strong></td>
<td>An arrangement of secondary equipment designed to protect primary equipment from damage by detecting a fault condition and sending a signal to disconnect the primary equipment from the transmission or distribution system.</td>
</tr>
<tr>
<td><strong>protection system</strong></td>
<td>A system designed to disconnect faulted primary equipment from the transmission or distribution system, which includes one or more protection schemes and which also includes the primary equipment used to effect the disconnection.</td>
</tr>
<tr>
<td><strong>quality of supply</strong></td>
<td>With respect to electricity, technical attributes to a standard set out in clause 2.2, unless otherwise stated in these Rules or the relevant connection agreement.</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>rapid bumpless transfer</strong></td>
<td>The make-before-break transfer of a load between the distribution system and an islanded generating unit (or vice versa) where the time for which the generating unit is operated in parallel with the distribution system is limited to less than 1 second.</td>
</tr>
<tr>
<td><strong>reactive energy</strong></td>
<td>A measure, in VAr hours (VArh) of the alternating exchange of stored energy in inductors and capacitors, which is the time-integral of the product of voltage and the out-of-phase component of current flow across a connection point.</td>
</tr>
<tr>
<td><strong>reactive equipment</strong></td>
<td>That equipment which is normally provided specifically to be capable of providing or absorbing reactive power, and includes the equipment identified in clause 5.4.1(f).</td>
</tr>
<tr>
<td><strong>reactive power</strong></td>
<td>The rate at which reactive energy is transferred, measured in VAr. Reactive power is a necessary component of alternating current electricity which is separate from active power and is predominantly consumed in the creation of magnetic fields in motors and transformers and produced by equipment such as: (a) alternating current generating units; (b) capacitors, including the capacitive effect of parallel transmission wires; (c) synchronous condensers. Reactive power is obtained from a combination of static and dynamic sources. Static sources include, for example, reactors and capacitor banks, and the charging current of transmission lines. Dynamic sources include, for example, synchronous machines, operating as generating units or synchronous compensators, static synchronous compensators, and static VAr compensators.</td>
</tr>
<tr>
<td><strong>reactive power capability</strong></td>
<td>The maximum rate at which reactive energy may be transferred from a generating unit to a connection point as specified in the relevant connection agreement.</td>
</tr>
<tr>
<td><strong>reactive power reserve</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>reactor</strong></td>
<td>A device, similar to a transformer, arranged to be connected into the transmission or distribution system during periods of low load demand or low reactive power demand to counteract the natural capacitive effects of long transmission lines in generating excess reactive power and so correct any transmission voltage effects during these periods.</td>
</tr>
</tbody>
</table>
| **region** | An area determined by the Network Service Provider to be a region, being an area served by a particular part of the transmission system containing one or more:

(a) concentrated areas of load or loads with a significant combined consumption capability; or

(b) concentrated areas containing one or more generating units with significant combined generating capability, or both. |
| **reliability** | A measure of the probability of equipment performing its function adequately for the period of time intended, under the operating conditions encountered. |
| **reliable** | The expression of a recognised degree of confidence in the certainty of an event or action occurring when expected. |
| **remote control equipment (RCE)** | Equipment installed to enable the Network Service Provider to control a generating unit circuit breaker or other circuit breaker remotely. |
| **remote monitoring equipment (RME)** | Equipment installed to enable the monitoring of other equipment from a remote control centre, and includes a remote terminal unit (RTU). |
| **representative** | In relation to a person, any employee, agent or consultant of:

(a) that person; or

(b) a related body corporate of that person; or

(c) a third party contractor to that person. |
<p>| <strong>reserve</strong> | The active power and reactive power available to the power system at a nominated time but not currently utilised. |
| <strong>revision</strong> | The revision to the Rules following an amendment under sections 12.50 -12.54, or a review under section 12.56 of the Access Code and approval by the Authority. |
| <strong>rotor angle stability</strong> | The ability of synchronous machines on an interconnected power system to remain in synchronism after being subjected to a disturbance, and which may comprise small-disturbance or transient stability, or both. Instability from a disturbance may occur in the form of increasing angular swings of some generating units, leading to loss of synchronism between generating units. Loss of synchronism can occur between one machine and the rest of the power system, or between groups of machines, with synchronism being maintained within each group after separating from each other. |
| <strong>RTU</strong> | A remote terminal unit installed within a substation to enable monitoring and control of equipment from a remote control centre. |
| <strong>Rules</strong> | These Rules, also called the &quot;Technical Rules&quot;, prepared by the Network Service Provider under Chapter 12 of the Access Code. |
| <strong>Rules commencement date</strong> | The date given in clause 1.4 of these Rules. |
| <strong>SCADA system</strong> | Supervisory control and data acquisition equipment which enables System Management or the Network Service Provider to monitor continuously and remotely, and to a limited extent control, the import or export of electricity from or to the power system. |
| <strong>scheduled generating unit</strong> | A generating unit which is dispatched by System Management. |
| <strong>secondary equipment</strong> | Equipment within a facility or the electricity transmission or distribution systems which does not carry the energy being transferred, but which is required for control, protection or operation of other equipment that does carry such energy. |
| <strong>security</strong> | The security of a power system is the degree of risk in its ability to survive imminent disturbances (contingencies) without interruption of service to Users. As it relates to the robustness of the system to imminent disturbances, it depends on the system operating condition as well as the contingent probability of disturbances. |
| <strong>sensitivity</strong> | In relation to protection schemes, has the meaning in clause 2.9.6. |
| <strong>service provider</strong> | The meaning given in the Access Code. |
| <strong>shunt capacitor</strong> | A type of equipment connected to a transmission or distribution system to generate reactive power. |
| <strong>shunt reactor</strong> | A type of equipment connected to a transmission or distribution system to absorb reactive power. |</p>
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>single contingency</td>
<td>In respect of a <em>transmission system</em>, a sequence of related events which result in the removal from service of one <em>transmission line</em>, <em>transformer</em> or other item of <em>equipment</em>. The sequence of events may include the application and clearance of a fault of defined severity.</td>
</tr>
<tr>
<td>small disturbance</td>
<td>A disturbance sufficiently small to permit the linearization of system equations for the purposes of analysis. The resulting system response involves small excursions of system variables from their pre-disturbance values. <em>Small disturbances</em> may be caused by routine switching (for example, line or capacitor), <em>transformer</em> tap changes, generating unit AVR set point changes, changes in the connected load, etc.</td>
</tr>
<tr>
<td>small-disturbance rotor angle stability</td>
<td>The ability of the <em>power system</em> to maintain <em>synchronism</em> under <em>small disturbances</em>.</td>
</tr>
<tr>
<td>small use customer</td>
<td>A <em>Consumer</em> that consumes less than 160 MWh of electricity per annum.</td>
</tr>
<tr>
<td>small zone fault</td>
<td>A fault which occurs on an area of <em>equipment</em> that is within the zone of detection of a <em>protection scheme</em>, but for which not all contributions to the fault will be cleared by the circuit breaker(s) tripped by that <em>protection scheme</em>. For example, a fault in the area of <em>equipment</em> between a <em>current transformer</em> and a circuit breaker, fed from the <em>current transformer</em> side, may be a <em>small zone fault</em>.</td>
</tr>
<tr>
<td>South West Interconnected Network or SWIN</td>
<td>The <em>transmission and distribution system</em> in South West of the state of Western Australia, extending from Geraldton to Albany areas and across to the Eastern Goldfields, as defined in the <em>Act</em>.</td>
</tr>
<tr>
<td>spare capacity</td>
<td>Any portion of firm capacity or non-firm capacity not committed to existing <em>Users</em>.</td>
</tr>
<tr>
<td>spinning reserve</td>
<td>Spinning <em>reserve ancillary service</em> as defined in the <em>Market Rules</em>, clause 3.9.</td>
</tr>
<tr>
<td>static excitation system</td>
<td>An <em>excitation control system</em> in which the power to the rotor of a <em>synchronous generating unit</em> is transmitted through high power solid-state electronic devices.</td>
</tr>
<tr>
<td>static VAr compensator (SVC)</td>
<td>A device provided on a <em>transmission or distribution system</em> specifically to provide the ability to generate and absorb <em>reactive power</em> and to respond automatically and rapidly to <em>voltage</em> fluctuations or <em>voltage</em> instability arising from a disturbance or disruption on the <em>transmission or distribution system</em>.</td>
</tr>
<tr>
<td><strong>static synchronous compensator (STATCOM)</strong></td>
<td>A device provided on a transmission or distribution system specifically to provide the ability to generate and absorb reactive power and to respond automatically and rapidly to voltage fluctuations or voltage instability arising from a disturbance or disruption on the transmission or distribution system.</td>
</tr>
<tr>
<td><strong>substation</strong></td>
<td>A facility at which lines are switched for operational purposes, and which may include one or more transformers so that some connected lines operate at different nominal voltages to others.</td>
</tr>
<tr>
<td><strong>supply</strong></td>
<td>The delivery of electricity as defined in the Act.</td>
</tr>
<tr>
<td><strong>supply transformer</strong></td>
<td>A transformer, forming part of the transmission system, which delivers electricity to the distribution system by converting it from the voltage of the transmission system to the voltage of the distribution system.</td>
</tr>
<tr>
<td><strong>synchronisation</strong></td>
<td>The act of synchronising a generating unit to the power system.</td>
</tr>
<tr>
<td><strong>synchronism</strong></td>
<td>A condition in which all machines of the synchronous type (generating units and motors) that are connected to a transmission or distribution system rotate at the same average speed, resulting in controlled sharing of the transfer of power. Loss of synchronism causes uncontrolled transfers of power between machine groups, causing severe and widespread disturbances of supply to Users, disconnection of transmission lines, possible damage to synchronous machines and system shutdown.</td>
</tr>
<tr>
<td><strong>synchronous condenser or synchronous compensator</strong></td>
<td>An item of equipment, similar in construction to a generating unit of the synchronous generating unit category, which operates at the equivalent speed of the frequency of the power system, provided specifically to generate or absorb reactive power through the adjustment of rotor current.</td>
</tr>
<tr>
<td><strong>synchronous generating unit voltage control</strong></td>
<td>The automatic voltage control system of a generating unit of the synchronous generating unit category which changes the output voltage of the generating unit through the adjustment of the generating unit rotor current and effectively changes the reactive power output from that generating unit.</td>
</tr>
<tr>
<td><strong>synchronous generating unit</strong></td>
<td>The alternating current generating units which operate at the equivalent speed of the frequency of the power system in its normal operating state.</td>
</tr>
<tr>
<td><strong>System Management</strong></td>
<td>The meaning given in the Market Rules.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>---------------------------------------</td>
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</tr>
<tr>
<td>tap-changing transformer</td>
<td>A transformer with the capability to allow internal adjustment of output voltages which can be automatically or manually initiated while on-line and which is used as a major component in the control of the voltage of the transmission and distribution systems in conjunction with the operation of reactive equipment. The connection point of a generating unit may have an associated tap-changing transformer, usually provided by the Generator.</td>
</tr>
<tr>
<td>technical envelope</td>
<td>The limits described in the Market Rules.</td>
</tr>
<tr>
<td>technical minimum</td>
<td>The minimum continuous active power output of a generating unit.</td>
</tr>
<tr>
<td>terminal station</td>
<td>A substation that transforms electricity between two transmission system voltages and which supplies electricity to zone substations but which does not supply electricity to the distribution system.</td>
</tr>
<tr>
<td>thermal generating unit</td>
<td>A generating unit which uses fuel combustion for electricity generation.</td>
</tr>
<tr>
<td>total fault clearance time</td>
<td>The time from fault inception to the time of complete fault interruption by a circuit breaker or circuit breakers. This is to be taken, as a minimum, to be equal to 10 milliseconds plus the circuit breaker maximum break time plus the maximum protection operating time.</td>
</tr>
<tr>
<td>transformer</td>
<td>A piece of equipment that reduces or increases the voltage of alternating current.</td>
</tr>
<tr>
<td>transformer tap position</td>
<td>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.</td>
</tr>
<tr>
<td>transient rotor angle stability</td>
<td>The ability of the power system to maintain synchronism when subjected to severe disturbances, for example a short circuit on a nearby transmission line. The resulting system response involves large excursions of generating unit rotor angles and is influenced by the non-linear power-angle relationship.</td>
</tr>
<tr>
<td>transmission</td>
<td>The functions performed by a transmission system, including conveying, transferring or permitting the passage of electricity.</td>
</tr>
<tr>
<td>transmission and distribution systems</td>
<td>The Network Service Provider's transmission system and the distribution system collectively.</td>
</tr>
</tbody>
</table>
| **transmission element** | A single identifiable major component of a transmission system involving:  
|                          | (a) an individual transmission circuit or a phase of that circuit;  
|                          | (b) a major item of transmission equipment necessary for the functioning of a particular transmission circuit or connection point (such as a transformer or a circuit breaker). |
| **transmission equipment** | The equipment associated with the function or operation of a transmission line or an associated substation, which may include transformers, circuit breakers, reactive equipment and monitoring equipment and control equipment. |
| **transmission line** | A power line that is part of a transmission system. |
| **transmission or distribution system** | Either the transmission system or the distribution system. |
| **transmission system** | Any apparatus, equipment, plant or buildings used, or to be used, for, or in connection with, the transportation of electricity at nominal voltages of 66 kV or higher, and which forms part of the South West Interconnected Network. For the avoidance of doubt the transmission system includes equipment such as static reactive power compensators, which is operated at voltages below 66 kV, provided that the primary purpose of this equipment is to support the transportation of electricity at voltages of 66 kV or higher. |
| **transmission system planning criteria** | The criteria prepared by the Network Service Provider under section A6.1(m) of the Access Code. |
| **trip circuit supervision** | A function incorporated within a protection scheme that results in alarming for the loss of integrity of the protection scheme’s trip circuit. Trip circuit supervision supervises a protection scheme’s trip supply together with the integrity of associated wiring, cabling and circuit breaker trip coil. |
| **trip supply supervision** | A function incorporated within a protection scheme that results in alarming for loss of trip supply. |
| **turbine control system** | The automatic control system which regulates the speed and power output of a generating unit through the control of the rate of entry into the generating unit of the primary energy input (for example, steam, gas or water). |
**two fully independent protection schemes of differing principle**

Protection schemes having differing principles of operation and which, in combination, provide dependable detection of faults on the protected primary equipment and operate within a specified time, despite any single failure to operate of the secondary equipment.

To achieve this, complete secondary equipment redundancy is required, including current transformer and voltage transformer secondaries, auxiliary supplies, signalling systems, cabling, wiring, and circuit breaker trip coils. Auxiliary supplies include DC supplies for protection purposes. Therefore, to satisfy the redundancy requirements, each protection scheme would need to have its own independent battery and battery charger system supplying all that protection scheme's trip functions.

In addition the relays of each protection scheme must be grouped in separate physical locations (which need not be in different panels). Furthermore the two protection schemes must either use different methods of operation or, alternatively, have been designed and manufactured by different organisations.

**User**

Has the meaning given in clause 1.3(b)(3).

**voltage**

The electronic force or electric potential between two points that gives rise to the flow of electricity.

**voltage stability**

The ability of a power system to attain steady voltages at all busbars after being subjected to a disturbance from a given operating condition.

Instability that may result occurs in the form of a progressive fall or rise of voltages at some busbars. Possible outcomes of voltage instability are loss of load in an area, or the tripping of transmission lines and other elements, including generating units, by their protective systems leading to cascading outages.

**voltage transformer (VT)**

A transformer for use with meters and/or protection devices in which the voltage across the secondary terminals is, within prescribed error limits, proportional to and in phase with the voltage across the primary terminals.

**WA Electrical Requirements**


**wind farm**

A power station consisting of one or more wind powered generating units.
| **written law** | The meaning given to it in section 5 of the *Interpretation Act 1984* (WA). |
| **zone substation** | A *substation* that transforms electricity from a *transmission system voltage* to a *distribution system voltage*. |
ATTACHMENT 2 - INTERPRETATION

In these Rules, headings and captions are for convenience only and do not affect interpretation and, unless the contrary intention appears from the context, and subject to the Act and the Access Code, these Rules must be interpreted in accordance with the following rules of interpretation:

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

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

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

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

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

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

(g) a connection point is a User's connection point or a connection point of a User if it is the subject of a connection agreement between the User and the Network Service Provider;

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

(i) measurements of physical quantities are in Australian legal units of measurement within the meaning of the National Measurement Act 1960 (Cth).
A3.1. Various sections of the Code require that Users submit technical data to the Network Service Provider. This Attachment 3 summarises schedules which list the typical range of data which may be required and explains the terminology. Data additional to those listed in the schedules may be required. The actual data required will be advised by the Network Service Provider at the time of assessment of a transmission or distribution access application, and will form part of the technical specification in the access contract or connection agreement.

A3.2. Data is coded in categories, according to the stage at which it is available in the build-up of data during the process of forming a connection or obtaining access to a transmission system, with data acquired at each stage being carried forward, or enhanced in subsequent stages, e.g. testing.

**Preliminary system planning data**

This is data required for submission with the access application or connection application, to allow the Network Service Provider to prepare an offer of terms for a connection agreement and to assess the requirement for, and effect of, transmission and distribution system augmentation or extension options. Such data is normally limited to the items denoted as Standard Planning Data (S) in the technical data schedules in Attachment 4 to Attachment 10.

The Network Service Provider may, in cases where there is doubt as to the viability of a proposal, require the submission of other data before making an access offer to connect or to amend an access contract or connection agreement.

**Registered system planning data**

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

**Registered data**

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

All of the data will, from this stage, be categorised and referred to as Registered Data; but for convenience the schedules omit placing a higher ranked code next to items which are expected to already be valid at an earlier stage.
A3.3. Data will be subject to review at reasonable intervals to ensure its continued accuracy and relevance. The Network Service Provider must initiate this review. A User may change any data item at a time other than when that item would normally be reviewed or updated by submission to the Network Service Provider of the revised data, together with authentication documents, egotist reports.

A3.4. Attachment 4 to Attachment 12, cover the following data areas:

(a) Attachment 4 – Large Generating Unit Design Data. This comprises large generating unit fixed design parameters.

(b) Attachment 5: Protection Systems Design and Setting Data. This comprises design and setting data for protection systems that must coordinate or interface with the protection systems for the transmission and distribution system or that could impact the operation of the transmission and distribution system.

(c) Attachment 6 – Large Generating unit Setting Data. This comprises settings which can be varied by agreement or by direction of the Network Service Provider.

(d) Attachment 7 - Transmission system and equipment Technical Data. This comprises fixed electrical parameters.

(e) Attachment 8 - Transmission equipment and Apparatus Setting Data. This comprises settings which can be varied by agreement or by direction of the Network Service Provider.

(f) Attachment 9 - Load Characteristics. This comprises the estimated parameters of load groups in respect of, for example, harmonic content and response to frequency and voltage variations.

(g) Attachment 10 - Design Data For Small Power Stations Connected To The Distribution System. This comprises a reduced set of design parameters that the Network Services Provider may require for small power stations covered by clause 3.6 of the Rules.

(h) Attachment 11 – Test Schedule for Specific Performance Verification and Model Evaluation of Large Generating Units. This comprises a schedule of commissioning and performance tests that the Network Service Provider may require for large generating units covered by clause 3.3 of the Rules.

(i) Attachment 12 – Testing and Commissioning of Small Power Stations Connected to the Distribution System. This comprises a schedule of commissioning and performance tests that the Network Service Provider may require for small power stations covered by clause 3.3 of the Rules.
A3.5. A *Generator* that connects a large *generating unit* that is not a *synchronous generating unit* must be given exemption from complying with those parts of schedules in Attachment 4 and 6 that are determined by the *Network Service Provider* to be not relevant to such *generating units*, but must provide the information required by with those parts of the schedules in Attachments 5, 7, 8 and 9 that are relevant to such *generating units*, as determined by the *Network Service Provider*. For this *non-synchronous generating unit*, additional data may be requested by the *Network Service Provider*.

Codes:

S = Standard Planning Data

D = Detailed Planning Data

R = Registered Data (R1 pre-connection, R2 post-connection)
### ATTACHMENT 4 - LARGE GENERATING UNIT DESIGN DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Data Description</th>
<th>Units</th>
<th>Data Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Power station technical data:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Connection point to Transmission system</td>
<td>Text, diagram</td>
<td>S, D</td>
</tr>
<tr>
<td></td>
<td>Nominal voltage at connection point to Transmission system</td>
<td>kV</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Total Power Station Sent Out Capacity</td>
<td>MW (sent out)</td>
<td>S, D, R2</td>
</tr>
<tr>
<td></td>
<td><strong>At connection point:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Symmetrical</td>
<td>kA</td>
<td>S, D</td>
</tr>
<tr>
<td></td>
<td>· Asymmetrical</td>
<td>kA</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>· Minimum zero sequence impedance</td>
<td>(a+jb) ohms</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>· Minimum negative sequence impedance</td>
<td>(a+jb) ohms</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td><strong>Individual synchronous generating unit data:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Make</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Model</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Rated MVA</td>
<td>MVA</td>
<td>S, D, R1</td>
</tr>
<tr>
<td></td>
<td>· Rated MW (Sent Out)</td>
<td>MW (sent out)</td>
<td>S, D, R1</td>
</tr>
<tr>
<td></td>
<td>· Rated MW (generated)</td>
<td>MW (Gen)</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>· Nominal Terminal Voltage</td>
<td>kV</td>
<td>D, R1</td>
</tr>
<tr>
<td></td>
<td>· Auxiliary load at PMAX</td>
<td>MW</td>
<td>S, D, R2</td>
</tr>
<tr>
<td></td>
<td>· Rated Reactive Output at PMAX</td>
<td>MVAr (sent out)</td>
<td>S, D, R1</td>
</tr>
</tbody>
</table>

1 Where applicable and unless requested otherwise, the data shall be provided at the site specific maximum ambient temperature.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
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<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>PMIN</td>
<td>Minimum Load (ML)</td>
<td>MW (sent out)</td>
<td>S, D, R2</td>
</tr>
<tr>
<td>H</td>
<td>Inertia Constant for all rotating masses connected to the generating unit shaft (for example, generating unit, turbine, etc)</td>
<td>MWs/rated MVA</td>
<td>S, D, R1</td>
</tr>
<tr>
<td>Hg</td>
<td>Generating unit Inertia Constant (applicable to synchronous condenser mode of operation)</td>
<td>MWs/rated MVA</td>
<td>S, D, R1</td>
</tr>
<tr>
<td>GSCR</td>
<td>Short Circuit Ratio</td>
<td></td>
<td>D, R1</td>
</tr>
<tr>
<td>ISTATOR</td>
<td>Rated Stator Current</td>
<td>A</td>
<td>D, R1</td>
</tr>
<tr>
<td>IROTOR</td>
<td>Rated Rotor Current at rated MVA and Power factor, rated terminal volts and rated speed</td>
<td>A</td>
<td>D, R1</td>
</tr>
<tr>
<td>VROTOR</td>
<td>Rotor Voltage at which IROTOR is achieved</td>
<td>V</td>
<td>D, R1</td>
</tr>
<tr>
<td>VCEIL</td>
<td>Rotor Voltage capable of being supplied for five seconds at rated speed during field forcing</td>
<td>V</td>
<td>D, R1</td>
</tr>
<tr>
<td>ZN</td>
<td>Neutral Earthing Impedance</td>
<td>(a+jb)%*</td>
<td></td>
</tr>
</tbody>
</table>

**Generating unit resistance:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA</td>
<td>Stator Resistance</td>
<td>% on MBASE</td>
<td>S, D, R1, R2</td>
</tr>
<tr>
<td>RF</td>
<td>Rotor resistance at 20°C</td>
<td>ohms</td>
<td>D, R1</td>
</tr>
</tbody>
</table>

* MVA base must be clearly stated.
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Data Description</th>
<th>Units</th>
<th>Data Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generating unit sequence impedances (saturated):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$Z_0$</td>
<td>Zero Sequence Impedance</td>
<td>$(a+jb)%$ on MBASE</td>
<td>D,R1</td>
</tr>
<tr>
<td>$Z_2$</td>
<td>Negative Sequence Impedance</td>
<td>$(a+jb)%$ on MBASE</td>
<td>D,R1</td>
</tr>
<tr>
<td>Generating unit reactances (saturated):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_{D}(sat)$</td>
<td>Direct Axis Transient Reactance</td>
<td>% on MBASE</td>
<td>D,R1</td>
</tr>
<tr>
<td>$X_{D}(sat)$</td>
<td>Direct Axis Sub-Transient Reactance</td>
<td>% on MBASE</td>
<td>D,R1</td>
</tr>
<tr>
<td>Generating unit reactances (unsaturated):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_D$</td>
<td>Direct Axis Synchronous Reactance</td>
<td>% on MBASE</td>
<td>S, D, R1, R2</td>
</tr>
<tr>
<td>$X_D'$</td>
<td>Direct Axis Transient Reactance</td>
<td>% on MBASE</td>
<td>S, D, R1, R2</td>
</tr>
<tr>
<td>$X_D''$</td>
<td>Direct Axis Sub-Transient Reactance</td>
<td>% on MBASE</td>
<td>S, D, R1, R2</td>
</tr>
<tr>
<td>$X_Q$</td>
<td>Quadrature Axis Synch Reactance</td>
<td>% on MBASE</td>
<td>D, R1, R2</td>
</tr>
<tr>
<td>$X_Q'$</td>
<td>Quadrature Axis Transient Reactance</td>
<td>% on MBASE</td>
<td>D, R1, R2</td>
</tr>
<tr>
<td>$X_Q''$</td>
<td>Quadrature Axis Sub-Transient Reactance</td>
<td>% on MBASE</td>
<td>D,R1, R2</td>
</tr>
<tr>
<td>$X_L$</td>
<td>Stator Leakage Reactance</td>
<td>% on MBASE</td>
<td>D, R1, R2</td>
</tr>
<tr>
<td>$X_O$</td>
<td>Zero Sequence Reactance</td>
<td>% on MBASE</td>
<td>D, R1</td>
</tr>
<tr>
<td>$X_2$</td>
<td>Negative Sequence Reactance</td>
<td>% on MBASE</td>
<td>D, R1</td>
</tr>
<tr>
<td>$X_P$</td>
<td>Potier Reactance</td>
<td>% on MBASE</td>
<td>D, R1</td>
</tr>
<tr>
<td>Generating unit time constants (unsaturated):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_D O'$</td>
<td>Direct Axis Open Circuit Transient</td>
<td>Seconds</td>
<td>S, D, R1, R2</td>
</tr>
<tr>
<td>$T_D O''$</td>
<td>Direct Axis Open Circuit Sub-Transient</td>
<td>Seconds</td>
<td>S, D, R1, R2</td>
</tr>
</tbody>
</table>
### TECHNICAL RULES FOR THE SOUTH WEST INTERCONNECTED NETWORK

### ATTACHMENT 4 – LARGE GENERATING UNIT DESIGN DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Unit</th>
<th>Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>TKD</td>
<td>Direct Axis Damper Leakage</td>
<td>Seconds</td>
<td>D, R1, R2</td>
</tr>
<tr>
<td>TQO'</td>
<td>Quadrature Axis Open Circuit Transient</td>
<td>Seconds</td>
<td>D, R1, R2</td>
</tr>
<tr>
<td>TA</td>
<td>Armature Time Constant</td>
<td>Seconds</td>
<td>D, R1, R2</td>
</tr>
<tr>
<td>TQO&quot;</td>
<td>Quadrature Axis Open Circuit Sub-Transient</td>
<td>Seconds</td>
<td>D, R1, R2</td>
</tr>
</tbody>
</table>

### Charts:

- **GCD**: Capability Chart, Graphical data, D, R1, R2
- **GOCC**: Open Circuit Characteristic, Graphical data, R1
- **GSCC**: Short Circuit Characteristic, Graphical data, R1
- **GZPC**: Zero power factor curve, Graphical data, R1
- **V curves**: Graphical data, R1
- **GOTC**: MW, MVAr outputs versus temperature chart, Graphical data, D, R1, R2

### Generating unit transformer:

- **GTW**: Number of windings, Text, S, D
- **GTRn**: Rated MVA of each winding, MVA, S, D, R1
- **GTTRn**: Principal tap rated voltages, kV/kV, S, D, R1
- **GTZ1n**: Positive Sequence Impedances (each wdg), (a + jb) % on 100 MVA base, S, D, R1
- **GTZ2n**: Negative Sequence Impedances (each wdg), (a + jb) % on 100 MVA base, S, D, R1
### TECHNICAL RULES FOR THE SOUTH WEST INTERCONNECTED NETWORK

ATTACHMENT 4 – LARGE GENERATING UNIT DESIGN DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Data Description</th>
<th>Units</th>
<th>Data Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTZOn</td>
<td>Zero Sequence Impedances (each wdg)</td>
<td>(a + jb) % on 100 MVA base</td>
<td>S, D, R1</td>
</tr>
<tr>
<td></td>
<td>Tapped Winding</td>
<td></td>
<td>S, D, R1</td>
</tr>
<tr>
<td>GTAPR</td>
<td>Tap Change Range</td>
<td>kV - kV</td>
<td>S, D</td>
</tr>
<tr>
<td>GTAPS</td>
<td>Tap Change Step Size</td>
<td>%</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Tap Changer Type, On/Off load</td>
<td>On/Off</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Tap Change Cycle Time</td>
<td>Seconds</td>
<td>D</td>
</tr>
<tr>
<td>GTVG</td>
<td>Vector Group</td>
<td>Diagram</td>
<td>S, D</td>
</tr>
<tr>
<td></td>
<td>Earthing Arrangement</td>
<td>Text, diagram</td>
<td>S, D</td>
</tr>
<tr>
<td></td>
<td>Saturation curve</td>
<td>Diagram</td>
<td>R1</td>
</tr>
</tbody>
</table>

**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 voltage and speed (for time)
- Leading *Reactive power* at rated MW: MVAr import S,D, R2

**Generating unit excitation system:**

- Make
- Model
- General description of *excitation control system* (including block diagram transfer function & parameters): Text, diagram S, D

DMS#: 6800863v9E

File#: NAC/77/2(30)V1
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Field Voltage at rated MVA and Power factor and rated terminal volts and speed</td>
<td>V</td>
<td>S, D, R1</td>
</tr>
<tr>
<td>Maximum Field Voltage</td>
<td>V</td>
<td>S, D, R1</td>
</tr>
<tr>
<td>Minimum Field Voltage</td>
<td>V</td>
<td>D, R1</td>
</tr>
<tr>
<td>Maximum rate of change of Field Voltage (rising)</td>
<td>V/s</td>
<td>D, R1</td>
</tr>
<tr>
<td>Maximum rate of change of Field Voltage (falling)</td>
<td>V/s</td>
<td>D, R1</td>
</tr>
</tbody>
</table>

*Generating unit and exciter Saturation Characteristics 50 - 120% V Diagram*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic Characteristics of Over Excitation Limiter (drawn on capability generating unit diagram)</td>
<td>Text/Block diagram</td>
<td>D, R2</td>
</tr>
<tr>
<td>Dynamic Characteristics of Under Excitation Limiter (drawn on capability generating unit diagram)</td>
<td>Text/Block diagram</td>
<td>D, R2</td>
</tr>
</tbody>
</table>

*Generating unit turbine / load controller (governor):*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General description of turbine control system (including block diagram transfer function &amp; parameters)</td>
<td>Text, diagram</td>
<td>S, D</td>
</tr>
<tr>
<td>Maximum Droop</td>
<td>%</td>
<td>S, D, R1</td>
</tr>
</tbody>
</table>
### Symbol Data Description | Units | Data Category
--- | --- | ---
Normal Droop | % | D, R1
Minimum Droop | % | D, R1
Maximum Frequency Dead band | Hz | D, R1
Normal Frequency Dead band | Hz | D, R1
Minimum Frequency Dead band | Hz | D, R1
MW Dead band | MW | D, R1

**Generating unit response capability:**

- Sustained response to *frequency change* | MW/Hz | D, R2
- Non-sustained response to *frequency change* | MW/Hz | D, R2
- Load Rejection Capability | MW | S, D, R2

**Mechanical shaft model:**

*(Multiple-stage steam turbine generating units only)*

- Dynamic model of turbine/generating unit shaft system in lumped element form showing component inertias, damping and shaft stiffness.
- 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 and Data for Large Generating Units

**Symbols KHP**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Unit of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>KIP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KLP1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KLP2</td>
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</table>

**Symbols THP**

<table>
<thead>
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<th>Unit of Measurement</th>
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<tr>
<td>TIP</td>
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</tr>
<tr>
<td>TLP1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TLP2</td>
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</tr>
</tbody>
</table>

**Stage and Reheat Time Constants**

- **Turbine Frequency Tolerance Curve**
  - Diagram: S, D, R1

**Gas Turbine Data**

- **HRSG**
  - Waste heat recovery boiler time constant (where applicable, e.g., for cogeneration equipment)
  - MW output versus turbine speed (47-52 Hz)
  - Type of turbine (heavy industrial, aero derivative etc)
  - Number of shafts
  - Gearbox Ratio

---

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<table>
<thead>
<tr>
<th>Symbol</th>
<th>Data Description</th>
<th>Units</th>
<th>Data Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fuel type (gas, liquid)</td>
<td>Text</td>
<td>S,D</td>
</tr>
<tr>
<td></td>
<td>Base load MW vs temperature</td>
<td>Diagram</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Peak load MW vs temperature</td>
<td>Diagram</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Rated exhaust temperature</td>
<td>°C</td>
<td>S,D</td>
</tr>
<tr>
<td></td>
<td>Controlled exhaust temperature</td>
<td>°C</td>
<td>S,D,R1</td>
</tr>
<tr>
<td></td>
<td>Turbine frequency tolerance capability</td>
<td>Diagram</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Turbine compressor surge map</td>
<td>Diagram</td>
<td>D</td>
</tr>
</tbody>
</table>

**Hydraulic turbine data**

Required data will be advised by the *Network Service Provider*

**Wind farm/wind turbine data**

A typical 24 hour power curve measured at 15-minute intervals or better if available;

maximum kVA output over a 60 second interval

Long-term flicker factor for generating unit

Long term flicker factor for wind farm

Maximum output over a 60 second interval

Harmonics current spectra

Power curve MW vs. wind speed

Spatial Arrangement of wind farm

Startup profile MW, MVAR vs time for individual Wind Turbine Unit and Wind farm Total

TECHNICAL RULES FOR THE SOUTH WEST INTERCONNECTED NETWORK

ATTACHMENT 4 – LARGE GENERATING UNIT DESIGN DATA

Low Wind Shutdown profile MW, MVAr vs time for individual Wind Turbine Unit and Wind farm Total

MW, MVAr vs time profiles for individual Wind Turbine Unit under normal ramp up and ramp down conditions.

High Wind Shutdown profile MW, MVAr vs time for individual Wind Turbine Unit and Wind farm Total

*Induction generating unit data*

Make

Model

Type (squirrel cage, wound rotor, doubly fed)

<table>
<thead>
<tr>
<th>MBASE</th>
<th>Rated MVA</th>
<th>MVA</th>
<th>S,D,R1</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSO</td>
<td>Rated MW (Sent out)</td>
<td>MW</td>
<td>S,D,R1</td>
</tr>
<tr>
<td>PMAX</td>
<td>Rated MW (generated)</td>
<td>MW</td>
<td>D</td>
</tr>
<tr>
<td>VT</td>
<td>Nominal Terminal Voltage</td>
<td>kV</td>
<td>S,D,R1</td>
</tr>
<tr>
<td></td>
<td>Synchronous Speed</td>
<td>rpm</td>
<td>S,D,R1</td>
</tr>
<tr>
<td></td>
<td>Rated Speed</td>
<td>rpm</td>
<td>S,D,R1</td>
</tr>
<tr>
<td></td>
<td>Maximum Speed</td>
<td>rpm</td>
<td>S,D,R1</td>
</tr>
<tr>
<td></td>
<td>Rated Frequency</td>
<td>Hz</td>
<td>S,D,R1</td>
</tr>
<tr>
<td>Qmax</td>
<td>Reactive consumption at PMAX</td>
<td>MVAr import</td>
<td>S,D,R1</td>
</tr>
</tbody>
</table>

Curves showing torque, power factor, efficiency, stator current, MW output versus slip (+ and -).

Graphical data D,R1,R2

Number of capacitor banks and MVAr size at rated voltage for each capacitor bank (if used).

Text S

Control philosophy used for VAr /voltage control.

Text S
**H** Combined inertia constant for all rotating masses connected to the generating unit shaft (for example, generating unit, turbine, gearbox, etc) calculated at the synchronous speed

**Resistance**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Units</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rs</td>
<td>Stator resistance</td>
<td>% on MBASE</td>
<td>D,R1</td>
</tr>
<tr>
<td>Rs</td>
<td>Stator resistance versus slip curve, or two extreme values for zero (nominal) and unity (negative) slip</td>
<td>Graphical data or % on MBASE</td>
<td>D,R1</td>
</tr>
</tbody>
</table>

**Reactances (saturated)**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Units</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>X'</td>
<td>Transient reactance</td>
<td>% on MBASE</td>
<td>D,R1</td>
</tr>
<tr>
<td>X''</td>
<td>Subtransient reactance</td>
<td>% on MBASE</td>
<td>D,R1</td>
</tr>
</tbody>
</table>

**Reactances (unsaturated)**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Units</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Sum of magnetising and primary winding leakage reactance.</td>
<td>% on MBASE</td>
<td>D,R1</td>
</tr>
<tr>
<td>X'</td>
<td>Transient reactance</td>
<td>% on MBASE</td>
<td>D,R1</td>
</tr>
<tr>
<td>X''</td>
<td>Subtransient reactance</td>
<td>% on MBASE</td>
<td>D,R1</td>
</tr>
<tr>
<td>Xl</td>
<td>Primary winding leakage reactance</td>
<td>% on MBASE</td>
<td>D,R1</td>
</tr>
</tbody>
</table>

**Time constants (unsaturated)**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Units</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>T'</td>
<td>Transient</td>
<td>sec</td>
<td>S,D,R1,R2</td>
</tr>
<tr>
<td>T''</td>
<td>Subtransient</td>
<td>sec</td>
<td>S,D,R1,R2</td>
</tr>
<tr>
<td>Ta</td>
<td>Armature</td>
<td>sec</td>
<td>S,D,R1,R2</td>
</tr>
<tr>
<td>To'</td>
<td>Open circuit transient</td>
<td>sec</td>
<td>S,D,R1,R2</td>
</tr>
<tr>
<td>To''</td>
<td>Open circuit subtransient</td>
<td>sec</td>
<td>S,D,R1,R2</td>
</tr>
</tbody>
</table>
Converter data

Control: transmission system commutated or self commutated

Additional data may be required by the Network Service Provider

Doubly fed induction generating unit data

Required data will be advised by the Network Service Provider
**ATTACHMENT 5 - SUBMISSION REQUIREMENTS FOR ELECTRICAL PLANT PROTECTION**

**Protection data submission timelines:**

D  Within 3 months of signing of the connection agreement, or as agreed otherwise in the connection agreement.

R1 At least 3 months prior to commencement of protection equipment commissioning, or as agreed otherwise in the connection agreement.

R2 Within 3 weeks of the completion of protection equipment commissioning, or as agreed otherwise in the connection agreement.

**Data Description**

**Protection Design Philosophy:**

Documentation explaining the general protection philosophy, including:

- Present and design minimum and maximum fault levels.

- Present and design minimum and maximum fault contributions to the network from the User, at the connection point.

- Details of required critical fault clearance times, and which protections will be employed to meet these times.

- Local Backup (circuit breaker fail) philosophy.

- Special scheme philosophy (for example, islanding or load shedding schemes).

- Protection number 1 philosophy

- Protection number 2 philosophy

Power single line diagram, down to and including the low voltage (greater than 50V AC) bus(s), including:

- Voltage levels,

- Transformer ratings, winding configurations and earthing connections

- Generator ratings and earthing connections

- Operating status of switching devices

- Earthing configuration
- Primary plant interlocks

Details of protection interfaces between the network and the User D, R1 and R2

Protection single line diagram, down to and including the low voltage (greater than 50V AC) bus(s), including:

- Current transformer locations, rated primary and secondary current, rated short-time thermal current, rated output, accuracy class and designation.

- Voltage Transformer locations, winding connections, rated primary and secondary voltages, rated output and accuracy class.

- Relay make and model number

- Relay functions employed

- Primary plant mechanical protections

- Trip details (diagramatic or by trip matrix)

Impedance diagram of the system, showing, for each item of primary plant, details of the positive, negative and zero sequence series and shunt impedances, including mutual coupling between physically adjacent elements. Impedances to be in per unit, referred to a 100MVA base.

Final submission (R2) to include tested values of generator and transformer impedances (for example, from manufacturer’s test certificates)

Tripping and control power supply (eg DC system) single line diagram. R1 and R2

Power flow details at point of connection as per the data requested in Attachment 5.

HV circuit breaker details, including:

- A control and protection schematic diagram of the circuit breaker(s) at the User connection to the network

- Type, rated current and rated fault MVA or rated breaking current of all HV circuit breakers

HV switch fuse details, including: R1 and R2

- Rated current of fuse

- Rated breaking current of fuse

- Type of fuse

- Current-time characteristic curves
**Protection Settings Design Philosophy:**

- Documentation explaining the general *protection* settings philosophy
  - R1 and R2
- Calculated *critical fault clearance times*
  - R1 and R2
- *Protection* function settings to be employed and reasons for selecting these settings. Diagrams to be submitted where applicable.
  - R1 and R2
- Overcurrent grading curves for phase faults.
  - R1 and R2
- Overcurrent grading curves for earth faults
  - R1 and R2
**Protection Data:**

Settings of the following protections:

- Loss of field Text D
- Under excitation Text, diagram D
- Over excitation Text, diagram D
- Differential Text D
- Under frequency Text D
- Over frequency Text D
- Negative sequence component Text D
- Stator overvoltage Text D
- Stator overcurrent Text D
- Rotor overcurrent Text D
- Reverse power Text D

**Control Data:**

Details of excitation control system incorporating, where applicable, individual elements for power system stabiliser, under excitation limiter and over excitation limiter described in block diagram form showing transfer functions of individual elements, parameters and measurement units (preferably in IEEE format, but suitable for use in the software package nominated by the Network Service Provider. Currently, that package is DigSilent): The source code of the model must also be provided, in accordance with clause 3.3.8.

Text, diagram D,R1,R2
Settings of the following controls:

Details of the turbine control system described in block diagram form showing transfer functions of individual elements and measurement units (preferably in IEEE format, but suitable for use in the software package nominated by the Network Service Provider. Currently, that package is DigSilent). The source code of the model must also be provided, in accordance with clause 3.3.8.

<table>
<thead>
<tr>
<th>Control</th>
<th>Text, diagram</th>
<th>D,R1,R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stator current limiter (if fitted)</td>
<td>Text, diagram</td>
<td>D</td>
</tr>
<tr>
<td>Manual restrictive limiter (if fitted)</td>
<td>Text</td>
<td>D</td>
</tr>
<tr>
<td>Load drop compensation/VAr sharing (if fitted)</td>
<td>Text, function</td>
<td>D</td>
</tr>
<tr>
<td>V/f limiter (if fitted)</td>
<td>Text, diagram</td>
<td>D</td>
</tr>
</tbody>
</table>
## ATTACHMENT 7 - TRANSMISSION SYSTEM AND EQUIPMENT TECHNICAL DATA OF EQUIPMENT AT OR NEAR CONNECTION POINT

### Data Description

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

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Transmission system Configuration

Operation Diagrams showing the electrical circuits of the existing and proposed main facilities within the User's ownership including busbar arrangements, phasing arrangements, earthing arrangements, switching facilities and operating voltages.

Transmission system Impedances

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

Short Circuit Infeed to the Transmission system


The total infeed at the instant of fault (including contribution of induction motors). kA D, R1

Minimum zero sequence impedance of User's transmission system at connection point. % on 100 MVA base D, R1

Minimum negative sequence impedance of User's transmission system at connection point. % on 100 MVA base D, R1

Load Transfer Capability:

Where a load, or group of loads, may be fed from alternative connection points:

Load normally taken from connection point X MW D, R1

Load normally taken from connection point Y MW D, R1

Arrangements for transfer under planned or fault outage conditions Text D
Circuits Connecting *Embedded generating units* to the *Transmission system*:

For all *generating units*, all connecting lines/cables, *transformers* etc.

<table>
<thead>
<tr>
<th>Series Resistance (+ve, -ve &amp; zero seq.)</th>
<th>% on 100 MVA base</th>
<th>D, R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Series Reactance (+ve, -ve &amp; zero seq.)</td>
<td>% on 100 MVA base</td>
<td>D, R</td>
</tr>
<tr>
<td>Shunt Susceptance (+ve, -ve &amp; zero seq.)</td>
<td>% on 100 MVA base</td>
<td>D, R</td>
</tr>
<tr>
<td>Normal and short-time emergency ratings</td>
<td>MVA</td>
<td>D,R</td>
</tr>
</tbody>
</table>

Technical Details of *generating units* as per schedules S1, S2

*Transformers at connection points:*

<table>
<thead>
<tr>
<th>Saturation curve</th>
<th>Diagram</th>
<th>R</th>
</tr>
</thead>
</table>
## ATTACHMENT 8 - TRANSMISSION SYSTEM EQUIPMENT AND APPARATUS SETTING DATA

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

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FACTS Installation:
Data sufficient to enable static and dynamic performance of the installation to be modelled Text, diagrams S, D, R1

Under frequency load shedding scheme:
Relay settings (frequency and time) Hz, seconds S, D

Islanding scheme:
Triggering signal (e.g. voltage, frequency) Text S, D
Relay settings Control settings S, D
## ATTACHMENT 9 - LOAD CHARACTERISTICS AT CONNECTION POINT

<table>
<thead>
<tr>
<th>Data Description</th>
<th>Units</th>
<th>Data Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>For all Types of Load</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of Load, eg controlled rectifiers or large motor drives</td>
<td>Text</td>
<td>S</td>
</tr>
<tr>
<td>Rated capacity</td>
<td>MW, MVA</td>
<td>S</td>
</tr>
<tr>
<td>Voltage level</td>
<td>kV</td>
<td>S</td>
</tr>
<tr>
<td>Rated current</td>
<td>A</td>
<td>S</td>
</tr>
<tr>
<td>Power factor range during normal operation</td>
<td>Text/diagram</td>
<td>S</td>
</tr>
<tr>
<td><strong>For Fluctuating Loads</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyclic variation of active power over period</td>
<td>Graph</td>
<td>S</td>
</tr>
<tr>
<td>Cyclic variation of reactive power over period</td>
<td>Graph</td>
<td>S</td>
</tr>
<tr>
<td>Maximum rate of change of active power</td>
<td>MW/s</td>
<td>S</td>
</tr>
<tr>
<td>Maximum rate of change of reactive power</td>
<td>MVAr/s</td>
<td>S</td>
</tr>
<tr>
<td>Shortest Repetitive time interval between fluctuations in active power and reactive power reviewed annually</td>
<td>s</td>
<td>S</td>
</tr>
<tr>
<td>Largest step change in active power</td>
<td>MW</td>
<td>S</td>
</tr>
<tr>
<td>Largest step change in reactive power</td>
<td>MVAr</td>
<td>S</td>
</tr>
<tr>
<td>For commutating power electronic load:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of pulses</td>
<td>Text</td>
<td>S</td>
</tr>
<tr>
<td>Maximum voltage notch</td>
<td>%</td>
<td>S</td>
</tr>
<tr>
<td>Harmonic current distortion</td>
<td>A or %</td>
<td>S</td>
</tr>
</tbody>
</table>

(up to the 50th harmonic)
# ATTACHMENT 10: DISTRIBUTION SYSTEM CONNECTED GENERATORS UP TO 10 MW (EXCEPT INVERTOR-CONNECTED GENERATORS UP TO 30 KVA)

<table>
<thead>
<tr>
<th>Power Station</th>
<th>Data Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Address</strong></td>
<td>S, R1</td>
</tr>
<tr>
<td>Description of power station, for example, is it a green or brownfield site, is there a process steam or heat requirement, any other relevant information</td>
<td>S</td>
</tr>
<tr>
<td>Site-specific issues which may affect access to site or design, eg other construction onsite, mine site, environmental issues, soil conditions</td>
<td>S, D</td>
</tr>
<tr>
<td>Number of generating units and ratings (kW)</td>
<td>S, D, R1</td>
</tr>
<tr>
<td>Type: eg synchronous, induction</td>
<td>S, D, R1</td>
</tr>
<tr>
<td>Manufacturer:</td>
<td>D</td>
</tr>
<tr>
<td>Connected to the network via: eg inverter, transformer, u/g cable etc</td>
<td>S</td>
</tr>
<tr>
<td>Prime mover types: eg reciprocating, turbine, hydraulic, photovoltaic, other</td>
<td>S</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>D</td>
</tr>
<tr>
<td>Energy source: eg natural gas, landfill gas, distillate, wind, solar, other</td>
<td>S</td>
</tr>
<tr>
<td>Total power station total capacity (kW)</td>
<td>S, D, R1</td>
</tr>
<tr>
<td>Power station export capacity (kVA)</td>
<td>S, D, R1</td>
</tr>
<tr>
<td>Forecast annual energy generation (kWh)</td>
<td>S, D</td>
</tr>
<tr>
<td>Normal mode of operation as per clause 3.6.2.3 of Technical Rules ie (a) continuous parallel operation (b) occasional parallel operation (c) short term test parallel operation (d) bumpless transfer, ( (1) rapid (2) gradual)</td>
<td>S</td>
</tr>
<tr>
<td>Purpose: eg power sales, peak lopping, demand management, exercising, emergency back up</td>
<td>S</td>
</tr>
</tbody>
</table>
**Associated Facility Load**

- **Expected peak load at facility (kW)**
  S, D, R1

- **Forecast annual energy consumption (kWh)**
  S

- **Construction supply required?**
  S

- **Max construction power**
  S

- **Required connection date**
  S

- **Required full operation date**
  S

- **Expected life**
  S

**Additional Information Required**

1. Proposed arrangement & site layout of the power station including prime movers, generators, transformers, synchronising circuit breakers and lockable disconnect device. Each component should be identified so that the plan can be cross-referenced to the data provided.  S, D

2. Single line diagram & earthing configuration  S, D, R2

3. Details of generator maximum kVA output over 60 second interval  S, D, R2

4. A typical 24 hour load power curve measured at 15 minute intervals or less  S, D, R2

5. Calculation of expected maximum symmetrical 3 phase fault current contribution  S, D,

6. Data on power quality characteristics for wind generators (including flicker and harmonics) to IEC 61400-21  S, D, R2

7. Where required by Western Power, aggregate data required for performing stability studies in accordance with clause 3.2.16 & 3.3.3 and results of preliminary studies (if available)  D
### Transformers\(^1\)

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Data Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifier(^3)</td>
<td></td>
<td>S</td>
</tr>
<tr>
<td>Number of windings</td>
<td>Number</td>
<td>S</td>
</tr>
<tr>
<td>Rated MVA of each winding</td>
<td>MVA</td>
<td>S, D</td>
</tr>
<tr>
<td>Principal tap rated voltages</td>
<td>kV/kV</td>
<td>S</td>
</tr>
<tr>
<td>Positive sequence impedances (each wdg)(^3)</td>
<td>(a+jb)(^%)</td>
<td>D, R1</td>
</tr>
<tr>
<td>Negative sequence impedances (each wdg)(^3)</td>
<td>(a+jb)(^%)</td>
<td>D, R1</td>
</tr>
<tr>
<td>Zero sequence impedances (each wdg)(^3)</td>
<td>(a+jb)(^%)</td>
<td>D, R1</td>
</tr>
<tr>
<td>Tapped winding</td>
<td>Text or diagram</td>
<td>S</td>
</tr>
<tr>
<td>Tap change range</td>
<td>kV-kV</td>
<td>D</td>
</tr>
<tr>
<td>Tap change step size</td>
<td>%</td>
<td>D</td>
</tr>
<tr>
<td>Number of taps</td>
<td>Number</td>
<td>D</td>
</tr>
<tr>
<td>Tap changer type, on/off load</td>
<td>On/Off</td>
<td>S</td>
</tr>
<tr>
<td>Tap change cycle time</td>
<td>S</td>
<td>D</td>
</tr>
<tr>
<td>Vector group</td>
<td>Text or diagram</td>
<td>S</td>
</tr>
</tbody>
</table>

### Attachments required

- Earthing arrangement
  - S, D

### Notes:

1. A separate data sheet is required for each transformer.
2. Where there is more than one transformer, the identifier should be the same as used on the single line diagram.
3. Base quantities must be clearly stated.
## Synchronous Generators

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Data Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifier</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Make</td>
<td>Text</td>
<td>D</td>
</tr>
<tr>
<td>Model</td>
<td>Text</td>
<td>D</td>
</tr>
<tr>
<td>Rated kVA</td>
<td>kVA</td>
<td>S, D, R1</td>
</tr>
<tr>
<td>Nominal terminal voltage</td>
<td>kV</td>
<td>D</td>
</tr>
<tr>
<td>Number of pole-pairs</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>rpm</td>
<td></td>
</tr>
<tr>
<td>Rated kW (sent out)</td>
<td>kW (sent out)</td>
<td>S, D, R1</td>
</tr>
<tr>
<td>Minimum load (ML)</td>
<td>kW (sent out)</td>
<td>D, R1</td>
</tr>
<tr>
<td>Inertia constant (H) for generator only</td>
<td>kW-sec/rated kVA</td>
<td>D, R1</td>
</tr>
<tr>
<td>Inertia constant (H) for all rotating masses connected to the kW-sec/rated kVA generator shaft (for example, generator, turbine, etc). Include gearbox (if any)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short circuit ratio</td>
<td></td>
<td>D, R1</td>
</tr>
<tr>
<td>Neutral earthing impedance</td>
<td>(a+jb)%</td>
<td>D, R1</td>
</tr>
</tbody>
</table>

### Sequence Impedances (saturated)

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Data Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero sequence impedance</td>
<td>(a+jb)%</td>
<td>D, R1</td>
</tr>
<tr>
<td>Negative sequence impedance</td>
<td>(a+jb)%</td>
<td>D, R1</td>
</tr>
</tbody>
</table>

### Reactances (saturated)

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Data Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct axis transient reactance</td>
<td>%</td>
<td>D, R1</td>
</tr>
<tr>
<td>Direct axis sub-transient reactance</td>
<td>%</td>
<td>D, R1</td>
</tr>
</tbody>
</table>

### Reactive capability (at machine terminals)

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Data Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum lagging (overexcited) reactive power at rated kW</td>
<td>kVAR export</td>
<td>S, D, R2</td>
</tr>
<tr>
<td>Maximum leading (underexcited) reactive power at rated kW</td>
<td>kVAR import</td>
<td>S, D, R2</td>
</tr>
<tr>
<td>Lagging reactive short time capability at rated kW, terminal</td>
<td>kVAR for time</td>
<td>D, R1</td>
</tr>
</tbody>
</table>

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voltagex and speed

Synchronous Generators (continued)

Attachments

Capability chart (Indicate effect of temperature and voltage)  Graphical data S, D, R1

Notes:
1: A separate data sheet is required for each generator.
2: Where there is more than one generator, the identifier should be the same as used on the single line diagram.
3: Base quantities must be clearly stated

Induction Generators

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Data Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifier²</td>
<td>Text</td>
<td>D</td>
</tr>
<tr>
<td>Make</td>
<td>Text</td>
<td>D</td>
</tr>
<tr>
<td>Model</td>
<td>Text</td>
<td>D</td>
</tr>
<tr>
<td>Rated kVA</td>
<td>kVA</td>
<td>S, D, R1</td>
</tr>
<tr>
<td>Rated kW (sent out)</td>
<td>kW (sent out)</td>
<td>S, D, R1</td>
</tr>
<tr>
<td>Reactive consumption at rated kW</td>
<td>kVAr</td>
<td>S, D, R1</td>
</tr>
<tr>
<td>Nominal terminal voltage</td>
<td>kV</td>
<td>D</td>
</tr>
<tr>
<td>Synchronous speed</td>
<td>rpm</td>
<td>D</td>
</tr>
<tr>
<td>Rated speed</td>
<td>rpm</td>
<td>D, R1</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>rpm</td>
<td>D, R1</td>
</tr>
<tr>
<td>Rated frequency</td>
<td>Hz</td>
<td>D</td>
</tr>
<tr>
<td>Single or (effectively) double cage machine</td>
<td>Text</td>
<td>D, R1</td>
</tr>
</tbody>
</table>

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File#: NAC/77/2(30)V1
**Generator reactances (saturated)**

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Data Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transient reactance²</td>
<td>%</td>
<td>D, R1</td>
</tr>
<tr>
<td>Subtransient reactance²</td>
<td>%</td>
<td>D, R1</td>
</tr>
<tr>
<td>Control: network commutated or self commutated</td>
<td>Text</td>
<td>S, R1</td>
</tr>
</tbody>
</table>

**Attachments**

- Curves showing torque, **power factor**, efficiency, stator current, kW output versus slip (+ and -). Graphical Data S, D, R1

**Notes:**
1. A separate data sheet is required for each generator.
2. Where there is more than one generator, the identifier should be the same as used on the single line diagram.
3. Base quantities must be clearly stated.

**Inverter-Connected Generators¹**

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Data Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifier²</td>
<td>text</td>
<td>D</td>
</tr>
<tr>
<td>Make</td>
<td>text</td>
<td>D</td>
</tr>
<tr>
<td>Model</td>
<td>text</td>
<td>D</td>
</tr>
<tr>
<td>Maximum kVA output over a 60 s interval</td>
<td>kVA</td>
<td>S, D, R1</td>
</tr>
</tbody>
</table>

**Maximum fault current contribution**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Data Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>kA rms symmetrical</td>
<td>S, D, R1</td>
</tr>
</tbody>
</table>

| Control modes (voltage, **power factor**) | text | S, D, R1 |

**Attachments**

- Reactive capability curve Graphical Data S, D, R1
- Long-term flicker factor for generator³ S, D, R2
- Long term flicker factor for windfarm³ S, D, R2
- Harmonics current spectra³ S, D, R2

**Notes:**
1. A separate data sheet is required for each generator.
2. Where there is more than one generator, the identifier should be the same as used on the single line diagram.

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Wind Turbine/Wind Farm

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Data Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flicker factors in accordance with IEC61400-21</td>
<td>Text / Diagram</td>
<td>S, D, R2</td>
</tr>
<tr>
<td>Annual average wind speed</td>
<td>metre/sec</td>
<td>S</td>
</tr>
<tr>
<td>Harmonics current spectra</td>
<td>Text / Diagram</td>
<td>S, D, R2</td>
</tr>
</tbody>
</table>

Attachments

- A typical 24 hour power curve measured at 15-minute intervals or better if available
- Startup profile kW, kVAR vs time for individual wind turbine
- Startup profile kW, kVAR vs time for wind farm total
- kW, kVAR vs time profiles for individual wind turbine under normal ramp up and ramp down conditions
- High wind shutdown profile kW, kVAR vs time for individual wind turbine
- High wind shutdown profile kW, kVAR vs time for wind farm total
- Low wind shutdown profile kW, kVAR vs time for individual wind turbine
- Low wind shutdown profile kW, kVAR vs time for wind farm total
- Power curve kW vs wind speed
- Spatial arrangement of wind farm

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File#: NAC/77/2(30)V1
A11.1 General

(a) Recorders must be calibrated/checked prior to use.
(b) Recorders must not interact with any equipment control functions.
(c) One chart recorder must be used to provide on site monitoring and rapid evaluation of key quantities during tests even though a digital recorder may be used.

A11.2 Recorder Equipment

Signals shall be digitally recorded and processed and require:

(a) an analogue to digital conversion with at least 12 bit accuracy at full scale;
(b) a sampling rate of at least 3000 samples per second (i.e. 3kHz) for up to 10 seconds unless specified otherwise;
(d) departure from linearity of no more than 0.1% in the slope of normalised output versus input. Normalised means value/full range value; and
(e) DC offset errors not greater than 0.05% of full scale in the analogue circuitry.

A11.3 Frequency response

(a) A minimum bandwidth of DC - 10kHz is required (0dB at DC, -3dB at 10kHz). Suitable filtering is required to eliminate aliasing errors.
(b) For relatively slowly changing signals (such as main exciter quantities, transducers for MW output etc) a recording device bandwidth of DC - 100Hz is required.
(c) All test results required in rms values are to be derived at a minimum rate of 100 samples per second.

A11.4 Signal Requirements and Conditioning

(a) Suitable input signal level must be used and allowance must be made for excursions during transients.
(b) Subtraction of an appropriate amount of floating DC from input signals such as stator voltage must be provided so that any perturbations are clearly observable on an on-site chart recorder.
(c) Galvanic isolation and filtering of input signals must be provided whenever necessary.
A11.5 Form of Test Results

These must consist of:

(a) a brief log showing when tests were done (time, date, test alphanumeric identification);
(b) chart recordings appropriately annotated;
(c) relevant schematics of equipment and the local transmission system configuration;
(d) lists of data collected manually (e.g. meter readings);
(e) data on Microsoft Excel spreadsheets;
(f) SCADA type printouts showing the User’s power system configuration at the start of, end of, and any other appropriate time during the test sequence; and
(g) other relevant data logger printouts (from other than the recorder equipment referred to in section A10.2).

A11.6 Test Preparation and Presentation of Test Results

Information/Data Prior to Tests

(a) A detailed schedule of tests agreed by the Network Service Provider. The schedule must list the tests, when each test is to occur and whose responsibility it will be to perform the test.
(b) Schematics of equipment and subnetworks plus descriptive material necessary to draw up/agree upon a schedule of tests
(c) Most up to date relevant technical data and parameter settings of equipment as specified in Attachment 4 to Attachment 9.

Test Notification

(a) A minimum of 15 business day prior notice of test commencement must be given to the Network Service Provider for the purpose of arranging witnessing of tests.
(b) The Network Service Provider's representative must be consulted about proposed test schedules, be kept informed about the current state of the testing program, and give permission to proceed before each test is carried out.
(c) Unless agreed otherwise, tests must be conducted consecutively.

Test Results

(a) Test result data must be presented to the Network Service Provider within 10 business days of completion of each test or test series.
(b) Where test results show that generator performance does not comply with the requirements of these Rules or the access contract or connection agreement it will be necessary to rectify problem(s) and repeat tests.

A11.7 Quantities to be Measured

(a) Wherever appropriate and applicable for the tests, the following quantities must be measured on the machine under test using either the same recorders or, where different recorders are used, time scales must be synchronised to within 1 msec:

**Generating unit and Excitation System**

- 3 stator L-N terminal voltages
- 3 stator terminal currents
- Active power MW
- Reactive power MVar
- Generating unit rotor field voltage
- Generating unit rotor field current
- Main exciter field voltage
- Main exciter field current
- AVR reference voltage
- Voltage applied to AVR summing junction (step etc)
- Power system stabiliser output
- DC signal input to AVR

**Steam Turbine**

- Shaft speed
- Load demand signal
- Valve positions for control and interceptor valves
- Turbine control set point
Gas turbine

- Shaft speed (engine)
- Shaft speed of turbine driving the *generating unit*
- Engine speed control output
- Free turbine speed control output
- *Generating unit*-compressor speed control output
- Ambient/turbine air inlet temperature
- Exhaust gas temperature control output
- Exhaust temperature
- Fuel flow
- Turbine control / *load* reference set point

Hydro

- Shaft speed
- Gate position
- Turbine control / *load* reference set point

(b) The *Network Service Provider* must specify test quantities for power equipment other than those listed above, such as those consisting of wind, solar and fuel cell *generating units* which may also involve AC/DC/AC power conversion or DC/AC power inverters.

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

(c) Key quantities such as stator terminal *voltages*, currents, *active power* and *reactive power* of other *generating units* on the same site and also *interconnection* lines with the transmission or *distribution system* (from control room readings) before and after each test must also be provided.
### SCHEDULE OF TESTS

**Table A11.1 - Schedule of tests**

<table>
<thead>
<tr>
<th>Test No</th>
<th>General Description</th>
<th>Changes Applied</th>
<th>Test Conditions</th>
</tr>
</thead>
</table>
| C1      | Step change to AVR voltage reference with the generating unit on open circuit | (a) +2.5 %  
(b) -2.5 %  
(c) +5.0 %  
(d) -5.0 % | • nominal stator terminal volts |
| C2A     | Step change to AVR voltage reference with the generating unit connected to the system. (with the Power system Stabiliser out of service)  

*Generating unit* output levels:  
(i)50% rated MW, and  
(ii)100% rated MW  

|   |   | (a) +1.0 %  
(b) -1.0 %  
(c) +2.5 %  
(d) -2.5 %  
(e) +5.0 %  
(f) -5.0 % | repeat (e) & (f) twice  
see note i. below  

|   |   | • nominal stator terminal volts  
|   |   | • unity or lagging *power factor*  
|   |   | • system base *load* OR typical conditions at the local *equipment* and typical electrical connection to the *transmission or distribution system*  
|   |   | • tests for (i) must precede tests for (ii)  
<p>|   |   | • smaller step <em>changes</em> must precede larger step <em>changes</em> |</p>
<table>
<thead>
<tr>
<th>Test No</th>
<th>General Description</th>
<th>Changes Applied</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2B</td>
<td>As for C2A but with the PSS in service</td>
<td>Same as in C2A</td>
<td>Same as in C2A</td>
</tr>
</tbody>
</table>
| C3A     | Step change to AVR voltage reference with the generating unit connected to the system. (With PSS out of service) | (a) +5 %  
(b) −5 %  
repeat (a) & (b) twice; | nominal stator terminal volts  
unity or lagging power factor  
Generating unit output at 100% rated MW |
|         | System Conditions:  
(i) system minimum load with no other generation on the same bus OR relatively weak connection to the transmission or distribution system, and  
(ii) system maximum load and maximum generation on same bus OR relatively strong connection to the transmission or distribution system | see note v. below | |
| C3B     | As for C3A but with the PSS in service | Same as in C3A | As for C3A. |
| C4      | Step change of MVA on the transmission or distribution system | Switching in and out of Transmission or distribution lines (nominated by the Network Service Provider) | nominal stator terminal volts  
unity or lagging power factor  
system base load OR typical conditions at the local equipment and typical electrical |
| PSS Status:  
(i) PSS in service, and | | | |
<table>
<thead>
<tr>
<th>Test No</th>
<th>General Description</th>
<th>Changes Applied</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ii)</td>
<td>PSS out of service</td>
<td></td>
<td>connection to the transmission or distribution system</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• generating unit output at 50% rated MW</td>
</tr>
<tr>
<td>C5</td>
<td>load rejection (real power)</td>
<td>(a) 25 % rated MW</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) 50 % rated MW</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) 100 % rated MW</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• nominal stator terminal volts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• unity power factor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• smaller amount must precede larger amount of load rejection</td>
</tr>
<tr>
<td>C6</td>
<td>steady state over-excitation limiter (OEL) operation</td>
<td>MVAr outputs at OEL setting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 100% MW output</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 75% MW output</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 50% MW output</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 25% MW output</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• min. MW output</td>
</tr>
<tr>
<td>C7</td>
<td>steady state under-excitation limiter (UEL) operation</td>
<td>MVAr outputs at UEL setting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 100% MW output</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 75% MW output</td>
</tr>
<tr>
<td>Test No</td>
<td>General Description</td>
<td>Changes Applied</td>
<td>Test Conditions</td>
</tr>
<tr>
<td>---------</td>
<td>---------------------</td>
<td>-----------------</td>
<td>----------------</td>
</tr>
<tr>
<td></td>
<td>slow lowering of excitation to just bring UEL into operation see notes below</td>
<td>• 50% MW output • 25% MW output • min. MW output</td>
<td></td>
</tr>
<tr>
<td>C8</td>
<td>Manual variation of generating unit open circuit voltage</td>
<td>Stator terminal volt (Ut) (a) increase from 0.5 pu to 1.1 pu (b) decrease from 1.1 pu to 0.5 pu see notes below</td>
<td>• in 0.1 pu step for Ut between 0.5-0.9 pu • in 0.05 pu step for Ut between 0.9-1.1 pu</td>
</tr>
<tr>
<td>C9</td>
<td>MVAr capability at full MW output. System maximum load and maximum generation. Test conducted with as high an ambient temperature as possible. Generating unit MW and MVAr output levels set to 100% of rated values and maintained for one hour.</td>
<td>• System maximum load and generation • Ambient temperature as high as possible</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

1. For tests C2A and C2B care must be taken not to excite large or prolonged oscillations in MW etc. Therefore, smaller step changes must always precede larger step changes to avoid such oscillations.

2. Figure A11.1 below shows the step changes referred to in the schedule of tests given above. An example is given of a +5% step to the summing junction and then a −5% step. Removal of the +5% ("+5%") step is deemed to be a −5% step.
Figure A11.1 - Application of step signal

Unless specified otherwise the "-5%" step method shown in Figure A11.1 is used.

3. For test C5, the instantaneous overspeed protection must be set at an agreed level depending on unit capability
4. "system" means "power system"
5. OR a lower step change, with a larger safety margin, as agreed by the Network Service Provider
6. Tests C1, C6, C7 and C8 need not be witnessed by the Network Service Provider
## SPECIAL SYSTEM TESTS THAT MAY BE REQUESTED

**Table A11.2 – Schedule of special system tests**

<table>
<thead>
<tr>
<th>Test No</th>
<th>General Description</th>
<th>Changes Applied</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Load rejection (reactive power)</td>
<td>(a) -30 % rated MVAR (b) +25 % rated MVAR see notes below</td>
<td>• nominal stator terminal volts • 0 or minimum MW output</td>
</tr>
<tr>
<td>S2</td>
<td>Load rejection (reactive power)</td>
<td>(a) -30 % rated MVAR see notes below</td>
<td>• nominal stator terminal volts • Excitation on Manual Control</td>
</tr>
<tr>
<td>S3</td>
<td>Step change of MVAR on the transmission system</td>
<td>Switching in and out of (a) a transformer (b) a reactor (c) a capacitor</td>
<td>• parallel transformers on staggered taps other as determined by the Network Service Provider</td>
</tr>
<tr>
<td>S4</td>
<td>Islanding of a subsystem consisting of User's generating units plus load with export of power by means of a link to the Network Service Provider's main transmission system.</td>
<td>opening of the link</td>
<td>• 5-10% of generated MW exported by means of the link • 90-95% of generated MW used by the subsystem's load</td>
</tr>
<tr>
<td>S5</td>
<td>AVR/OEL changeover</td>
<td>transformer tap change OR small step to AVR voltage reference</td>
<td>• initially under AVR control at lagging power factor but close to OEL limit</td>
</tr>
<tr>
<td>S6</td>
<td>AVR/UEL changeover</td>
<td>transformer tap change OR small step to AVR</td>
<td>• initially under AVR control at leading power</td>
</tr>
<tr>
<td>S7</td>
<td>Testing of a FACTS device (SVC, TCR, STATCOM, etc)</td>
<td>Voltage reference factor but close to UEL limit</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• step change to reference value in the summing junction of a control element</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• line switching</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• others as appropriate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MVA initial conditions in lines as determined by the Network Service Provider</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S8</td>
<td>Tripping of an adjacent generating unit</td>
<td>Tripping of generating unit(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MVA initial conditions in lines as determined by the Network Service Provider</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S9</td>
<td>Variable frequency injection into the AVR summing junction (with PSS out of service)</td>
<td>0.01-100 rad/sec see notes below</td>
<td>as determined by the Network Service Provider</td>
</tr>
<tr>
<td>S10</td>
<td>Step change to governor/load reference (a) 2.5 % step increase in MW demand signal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) 2.5 % decrease in MW demand signal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(c) equivalent of 0.05Hz subtracted from the governor speed ref.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(d) equivalent of 0.1 Hz added to governor speed reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>see notes below</td>
<td>equipment output at 50-85% of rated MW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>others as agreed with the Network Service Provider</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S11</td>
<td>Overspeed capability to stay in the range of 52.0 to 52.5Hz for a minimum of 6 seconds</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Digital governor: use software, where practical, to put a step in the speed reference of the turbine governor such that the target speed is</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unsynchronised unit at rated speed and no load</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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52.0Hz and the overshoot in speed remains above 52Hz and in the range 52-52.5Hz for about 6 sec

(b) Use a manual control to raise speed from 50Hz so as to stay in the 52 to 52.5 Hz range for a minimum of 6 sec

(c) Where it is practical, use a function generating unit to inject an analogue signal in the appropriate summing junction, so that the turbine stays in the 52-52.5 Hz range for a minimum of 6 sec.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>S12</td>
<td>Underspeed capability</td>
</tr>
<tr>
<td></td>
<td>To be proposed by the manufacturer</td>
</tr>
<tr>
<td>S13</td>
<td>Any other test to demonstrate compliance with a declared or registered equipment performance characteristic.</td>
</tr>
<tr>
<td></td>
<td>To be advised</td>
</tr>
</tbody>
</table>

Notes:

1. For tests S1(a) and S2 the VAr absorption must be limited so that field voltage does not go below 50% of its value at rated voltage and at no load (i.e. rated stator terminal voltage with the generating unit on open circuit).

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

3. For test S1 and S2, the instantaneous overvoltage protection must be operative and set at an agreed level greater than or equal to 10% overvoltage.
4. For test S2, it may be easier to use AVR control first and then change to manual (provided the change is "bumpless") before the unit trips.

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

6. For the tests S10 equipment characteristics may require the changes be varied from the nominal values given. Larger changes may be considered in order to more accurately determine equipment performance.

For test S5 a positive step is applied of X% from the sub-OEL value. But for test S6 a –Y% step from the sub-UEL value as shown in Figure A11.2 is required.

![Figure A11.2 - Application of Step Signal](image-url)
A12.1 Application

This attachment specifies the specific requirements for the certification, testing and commissioning of generating units connecting to the distribution system in accordance with clause 3.6 and for which the provisions of clause 4.2 apply.

A12.2 Certification

The Generator must provide certification by a chartered professional engineer with National Professional Engineers’ Register Standing in relevant areas of expertise that the facilities comply with the Rules, the relevant connection agreement, good engineering practice and relevant standards. The certification must confirm that the following have been verified:

1. The single line diagram approved by the Network Services Provider has been checked and accurately reflects the installed electrical system;
2. All required switches present and operate correctly as per the single line diagram;
3. The specified generation facility is the only source of power that can be operated in parallel with the distribution network;
4. The earthing systems complies with Australian Standards AS3000 and AS2067 and do not rely upon the Network Service Provider’s earthing system;
5. Electrical equipment is adequately rated to withstand specified network fault levels;
6. All protection apparatus (that serves a network protection function, including backup function) complies with IEC 60255 and has been correctly installed and tested. Interlocking systems specified in the connection agreement have been correctly installed and tested;
7. The islanding protection operates correctly and disconnects the small power station from the network within 2 seconds;
8. Synchronizing and auto-changeover equipment has been correctly installed and tested;
9. The delay in reconnection following restoration of normal supply is greater than 1 minute;
10. The protection settings specified in the connection agreement have been approved by the Network Services Provider and are such that satisfactory coordination is achieved with the Network Service Provider’s protection systems;
11. Provision has been made to minimise the risk of injury to personnel or damage to equipment that may be caused by an out-of-synchronism fault;
12. Control systems have been implemented to maintain voltage, active power flow and reactive power flow requirements for the connection point as specified in the connection agreement;
13. Systems or procedures are in place such that the testing, commissioning, operation and maintenance requirements specified in the Rules and the connection agreement are adhered to; and
14. Operational settings as specified.
A12.3 Pre-commissioning

Commissioning may occur only after the installation of the metering equipment.

A12.4 Commissioning Procedures

The commissioning of a generating unit shall include the checks and tests specified in clauses A12.5 to A12.14.

A.12.5 Operating Procedures

- The single line diagram shall be checked to confirm that it accurately reflects the installed plant;
- The documented operating procedures agreed with the Network Service Provider and have been implemented as agreed;
- Naming, numbering and labelling of plant agreed with the Network Service Provider has been followed; and
- Operating personnel are familiar with the agreed operating procedures and all requirements to preserve the integrity of the protection settings and interlocks and the procedures for subsequent changes to settings.

A12.6 Protection Systems

- Protection apparatus has been manufactured and installed to required standards;
- The settings and functioning of protection systems required for the safety and integrity of the distribution system operate correctly (at various power levels) and coordinate with the Network Service Provider’s protection systems. This will include the correct operation of the protection systems specified in the connection agreement and, in particular,
  - islanding protection and coordination with automatic relosers export/import limiting protection;
  - automatic changeover schemes; and
  - fail-safe generator shutdown for auxiliary supply failure or loss of distribution system supply; and
- Any required security measures for protection settings are in place.

A12.7 Switchgear Installations

- Switchgear, instrument transformers and cabling have been manufactured, installed and tested to required standards.

A12.8 Transformers

- Transformer(s) has been installed and tested to required standards; and
- Transformer parameters (nameplate inspection) are as specified and there is correct functioning of on-load tap changing (when supplied).
A12.9 **Earthing**

- The earthing connections and the design value(s) of earthing electrode impedance are delivered; and
- The earthing systems comply with *Australian Standards* AS3000 and AS2067 and do not rely upon the *Network Service Provider’s* earthing system.

A12.10 **Generating Units**

A12.10.1 **Unsynchronised/ disconnected**

- *Generating unit* parameters are as specified (nameplate inspection);
- *Generating units* have been manufactured to meet the requirements of the *Rules* for riding through power system disturbances;
- Earthing arrangements of the generating unit are as specified;
- Correct functioning of automatic *voltage* regulator for step changes in error signals (when specified);
- Achievement of required automatic *voltage* regulator response time (when specified); and
- Correct functioning of automatic synchronizing *equipment* prior to synchronisation.

A12.10.2 **Voltage Changes**

- Voltage transients at the *connection point* on connection are within specified limits; and
- Step changes in *voltage* on connection and disconnection (both before and after tap-changing) are within required limits.

A12.10.3 **Synchronous Generating Units**

- The *generating unit* is capable of specified sustained output of *real power* (when required);
- The *generating unit* is capable of required sustained generation and absorption of *reactive power*, (when required);
- Correct operation of over- and under-excitation limiters (when required); and
- Response time in constant *power factor* mode is within limits (when required).

A12.10.4 **Asynchronous Generating Units**

- Starting inrush current is within specified limits;
- *Power factor* during starting and normal operation is within specified limits; and
- Rating and correct operation of reactive power compensation *equipment*.

A12.10.5 **Inverter connected Generating Units**

- *Power factor* during starting and normal operation is within specified limits; and
- Rating and correct operation of reactive power compensation *equipment*.
A.12.10.6  Harmonics and Flicker

- Network flicker and harmonics levels before and after connection and confirmation that limits have not been exceeded (not required for directly connected rotating machines).

A12.10.7  Additional Requirement for Wind Farms

- The level of variation in the output of a wind generating unit or wind farm is within the limits specified in the connection agreement.

A12.11  Interlocks and Intertripping

- Correct operation of interlocks, check synchronizing, remote control, permissive interlocking and intertripping.

A12.12  Voice and Data Communications

- Correct operation of primary and back up voice and data communications systems

A12.13  Signage and Labelling

- Signage and labelling comply with that specified in the relevant connection agreement.

A12.14  Additional Installation Specific Tests

- The Network Service Provider may specify additional installation specific tests and inspections in respect of the physical and functional parameters that are relevant for parallel operation of the small power station and coordination with the distribution and transmission system.

A12.15  Routine Testing

- The Generator must test generating unit protection systems, including backup functions, at regular intervals not exceeding 3 years for unmanned sites and 4 years for manned sites and keep records of such tests.
- Where in-built inverter protection systems compliant with the AS4777-2005 requirements are permitted in small power stations with an aggregate rating of more than 30kVA but less than 100kVA, these protection systems must be tested for correct functioning at regular intervals not exceeding 5 years. The User must arrange for a suitably qualified person to conduct and certify the tests and supply the results to the Network Service Provider.

A12.16  Non-routine Testing
The Network Service Provider may inspect and test the small power station to re-confirm its correct operation and continued compliance with the Rules, connection agreement, good engineering practice and relevant standards. In the event that the Network Service Provider considers that the installation poses a threat to safety, to quality of supply or to the integrity of the distribution and transmission system it may disconnect the generating equipment.
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