

INTERIM

ELECTRICITY TRANSMISSION ACCESS

TECHNICAL CODE



Western Power

**Western Power Corporation
Customer Services & Business
Development Branch
Networks Business Unit
363-365 Wellington Street
Perth Western Australia 6000
GPO Box L921 Perth WA 6001**

Version 2 – as of 7 December 2004

IMPORTANT NOTE: This document is subject to amendment (amendments must be performed in accordance with the Electricity Transmission Regulations 1996). People referring to this document are advised to consult the Manager Networks Customer Services & Business Development, Western Power Corporation, to ensure that they have the latest version. The document is available for downloading at Western Power's internet site: www.westernpower.com.au

PREFACE

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

The Act requires that Western Power provides open access to capacity in its electricity transmission and distribution networks. The principal objective of open access is to facilitate competition in the energy industry by allowing independent generators to supply associated loads by utilising Western Power’s networks. For the electricity transmission networks, open access to capacity commenced on 1 January 1997; the date on which the Electricity Transmission Regulations 1996 (the “Regulations”) came into operation. Regulation 26 of the Regulations requires Western Power to publish a Technical Code (“Code”). In addition, regulation 27 of the Regulations requires Western Power to publish network planning criteria. The network planning criteria is included in this document.

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

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

Manager Network Customer Services & Business Development
Networks Business Unit
Western Power Corporation
GPO Box L921
PERTH WA 6001
Telephone: (08) 9326 6687
Facsimile: (08) 9326 6550

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

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

This page has been left blank intentionally.



TABLE OF CONTENTS

1	GENERAL	1
1.1	AUTHORISATION	1
1.2	APPLICATION	2
1.3	COMMENCEMENT	3
1.4	INTERPRETATION	3
1.5	DISPUTE RESOLUTION	3
1.6	OBLIGATIONS	3
1.6.1	Obligations of <i>Users</i>	3
1.6.2	Obligations of <i>Western Power</i>	3
1.6.3	Obligations of <i>Users With Loads</i>	4
1.6.4	Obligations of <i>Generators</i>	5
1.7	VARIATIONS AND EXEMPTIONS FROM, AND AMENDMENTS TO, THE CODE	5
1.7.1	Variations and Exemptions to the Code	5
1.7.2	Amendments to the Code	5
2.	TRANSMISSION NETWORK PERFORMANCE AND PLANNING CRITERIA	6
2.1	INTRODUCTION	6
2.2	POWER QUALITY	6
2.2.1	<i>Frequency Variations</i>	6
2.2.2	<i>Power Frequency Voltage Variations</i>	7
2.2.3	<i>Voltage fluctuations</i>	8
2.2.4	<i>Voltage Waveform Distortion</i>	9
2.2.5	<i>Voltage Unbalance</i>	11
2.2.6	<i>Electromagnetic Interference</i>	12
2.2.7	<i>Assessment of Power Quality</i>	13
2.3	STABILITY	13
2.3.1	<i>Rotor Angle Stability</i>	14
2.3.1.1	<i>Damping of Power System Oscillations</i>	15
2.3.2	<i>Frequency Stability</i>	16
2.3.3	<i>Voltage Stability</i>	16
2.3.3.2	<i>Temporary Over-Voltages</i>	17
2.3.3.3	<i>Transient Over-Voltages</i>	17

2.3.3.4	Transient Voltage Dip Criteria (TVD).....	17
2.3.3.5	Post-Fault Voltage Recovery Limit	18
2.3.4	Stability Assessment	18
2.3.4.1	Fault Types to be Studied.....	18
2.4	LOAD SHEDDING FACILITIES	23
2.4.1	<i>Load to be Available for Disconnection</i>	23
2.4.2	Installation and Testing of <i>Load Shedding Facilities</i>	23
2.4.3	Existing Settings of <i>Under-frequency Load Shedding Schemes</i>	24
2.5	RELIABILITY OF THE TRANSMISSION NETWORK.....	24
2.5.1	Stuck Breaker Criterion	26
2.6	STEADY STATE CRITERIA.....	26
2.6.1	Steady State Voltage Limits	27
2.6.2	Thermal Limits	27
2.6.3	Fault Limits	27
2.6.4	Generating Limits	28
2.6.5	Reactive Planning Process	28
2.7	SAFETY CRITERIA.....	29
2.8	ENVIRONMENTAL CRITERIA.....	29
2.8.1	Social Issues	29
2.8.2	Land-use Considerations	29
3.	<i>TECHNICAL REQUIREMENTS OF USER FACILITIES</i>.....	30
3.1	INTRODUCTION	30
3.2	REQUIREMENTS FOR <i>CONNECTION OF GENERATORS</i>	30
3.2.1	Technical Characteristics	31
3.2.2	Technical Matters to be Co-ordinated.....	31
3.2.3	Provision of Information	32
3.2.4	Detailed Technical Requirements Requiring Ongoing Verification	32
3.2.4.1	<i>Reactive Power Capability</i>	32
3.2.4.2	Quality of Electricity Generated.....	34
3.2.4.3	Generating Unit Response to Disturbances in the <i>Power System</i>	34
3.2.4.4	Partial <i>Load Rejection</i>	36
3.2.4.5	<i>Loading Rates</i>	36
3.2.4.6	Safe Shutdown without External <i>Electricity Supply</i>	36
3.2.4.7	Restart following Restoration of External <i>Electricity Supply</i>	37
3.2.4.8	Protection of Generating Units From Power System Disturbances.....	37
3.2.4.9	User Protection Systems that Impact on Power System Security	38
3.2.4.10	Generator <i>Transformer Tapping</i>	38
3.2.4.11	Tripping of Generating Units and Associated Loads	38

3.2.5	Monitoring and Control Requirements	38
3.2.5.1	Remote monitoring	38
3.2.5.2	Communications Equipment	39
3.2.5.3	Turbine Control System	40
3.2.5.4	Excitation Control System	41
3.2.6	Power Station Auxiliary <i>Transformers</i>	44
3.2.7	Synchronising	44
3.2.8	Secure Electricity Supplies.....	44
3.2.9	Design Requirements for <i>Users' Substations</i>	45
3.2.10	Computer Model.....	45
3.2.11	Plant Performance during Start-up, Shut-down and Daily Operation	45
3.3	REQUIREMENTS FOR CONNECTION OF LOADS	46
3.3.1	Information.....	46
3.3.2	Design Standards	47
3.3.3	User Protection Systems that Impact on Power System Security	47
3.3.4	Connection Point for a User	47
3.3.5	<i>Power Factor</i> Requirements	47
3.3.6	Design Requirements for <i>Users' Substations</i>	48
3.3.7	Load Shedding Facilities.....	49
3.3.8	Monitoring and Control Requirements	49
3.3.8.1	Remote Monitoring.....	49
3.3.8.2	Communications Equipment	50
3.3.9	Secure Electricity Supplies.....	50
3.4	PROTECTION REQUIREMENTS	51
3.4.1	Obligation to Provide Adequate <i>Protection</i>	51
3.4.1.1	Safety of People	51
3.4.1.2	System Reliability and Integrity	51
3.4.2	Overall <i>Protection</i> Requirements	51
3.4.2.1	Minimum Standard of <i>Protection</i> Equipment	51
3.4.2.2	Availability of <i>Protection</i>	52
3.4.2.3	Duplication of <i>Protection</i>	52
3.4.2.4	<i>Protection</i> Performance where Critical Fault Clearance Time Exists	52
3.4.2.5	Maximum Acceptable <i>Total Fault Clearance Time</i>	52
3.4.2.6	Sensitivity of Protection	54
3.4.2.7	Clearance of <i>Small Zone Faults</i>	54
3.4.2.8	Clearance of Faults under Circuit Breaker Fail Conditions	54
3.4.2.9	Protection of Interconnections and Ties.....	54
3.4.2.10	DC Functions of <i>Protection Apparatus</i>	55
3.4.2.11	<i>Protection</i> Flagging and Indication.....	55

3.4.2.12	<i>Trip Supply Supervision Requirements</i>	55
3.4.2.13	<i>Trip Circuit Supervision Requirements</i>	55
3.4.2.14	<i>Details of Proposed User Protection</i>	55
3.4.2.15	<i>Details of Proposed User Protection Settings</i>	55
3.4.2.16	<i>Coordination of Protection Settings</i>	56
3.4.2.17	<i>Commissioning of Protection</i>	56
3.4.2.18	<i>Maintenance of Protection</i>	56
3.4.3	<i>Specific Protection Requirements</i>	56
3.4.3.1	<i>Transmission Lines and other Plant Operated at 66kV and above</i>	56
3.4.3.2	<i>Feeders, Reactors, Capacitors and other Plant Operated below 66 kV</i>	57
3.4.3.3	<i>Transformers</i>	57
3.4.3.4	<i>Generators</i>	57
3.4.3.5	<i>Check Synchronising</i>	58
3.4.3.6	<i>Protection Alarm Requirements</i>	58
3.4.3.7	<i>Backup Protection</i>	58
3.4.3.8	<i>Islanding of a User's Facilities from the Power System</i>	59
3.4.3.9	<i>Automatic Reclose Equipment</i>	59
4.	<i>INSPECTION, TESTING, COMMISSIONING, DISCONNECTION AND RECONNECTION</i>	60
4.1	<i>INSPECTION AND TESTING</i>	60
4.1.1	<i>Right of Entry and Inspection</i>	60
4.1.2	<i>Right of Inspection and Testing</i>	62
4.1.3	<i>Tests to Demonstrate Compliance with Connection Requirements for Generators</i> 63	
4.1.4	<i>Routine Testing of Protection Equipment</i>	65
4.1.5	<i>Testing by Users of their own Plant Requiring Changes to Agreed Operation</i> ..	65
4.1.6	<i>Tests of Generating Units Requiring Changes to Agreed Operation</i>	66
4.1.7	<i>Power System Tests</i>	67
4.2	<i>COMMISSIONING</i>	68
4.2.1	<i>Requirement to Inspect and Test Equipment</i>	68
4.2.2	<i>Co-ordination during Commissioning</i>	68
4.2.3	<i>Control and Protection Settings for Equipment</i>	68
4.2.4	<i>Commissioning Program</i>	69
4.2.5	<i>Commissioning Tests</i>	69
4.3	<i>DISCONNECTION AND RECONNECTION</i>	70
4.3.1	<i>Voluntary Disconnection</i>	70
4.3.2	<i>Decommissioning Procedures</i>	71
4.3.3	<i>Involuntary Disconnection (refer also to clause 5.8)</i>	71
4.3.4	<i>Disconnection due to Breach of an Access Agreement</i>	71

4.3.5	<i>Disconnection during an Emergency</i>	71
4.3.6	<i>Obligation to Reconnect</i>	72
5.	<i>POWER SYSTEM SECURITY</i>	73
5.1	INTRODUCTION	73
5.1.1	<i>Purpose and Application of Section 5</i>	73
5.2	<i>POWER SYSTEM SECURITY PRINCIPLES</i>	73
5.2.1	<i>Satisfactory Operating State</i>	73
5.2.2	<i>Secure Operating State</i>	74
5.2.3	<i>Technical Envelope</i>	74
5.2.4	<i>General Principles for Maintaining Power System Security</i>	75
5.2.5	<i>Time for Undertaking Action</i>	76
5.3	<i>POWER SYSTEM SECURITY RESPONSIBILITIES AND OBLIGATIONS</i>	76
5.3.1	<i>Responsibility of Western Power for Power System Security</i>	76
5.3.2	<i>Western Power's Obligations</i>	77
5.3.3	<i>User Obligations</i>	78
5.4	<i>POWER SYSTEM FREQUENCY CONTROL</i>	78
5.4.1	<i>Power System Frequency Control Responsibilities</i>	78
5.4.2	<i>Operational Frequency Control Requirements</i>	78
5.5	<i>CONTROL OF TRANSMISSION NETWORK VOLTAGES</i>	79
5.5.1	<i>Transmission Network Voltage Control</i>	79
5.5.2	<i>Reactive Power Reserve Requirements</i>	80
5.5.3	<i>Audit and Testing</i>	80
5.6	<i>PROTECTION OF POWER SYSTEM EQUIPMENT</i>	80
5.6.1	<i>Power System Fault Levels</i>	80
5.6.2	<i>Power System Protection Co-ordination</i>	80
5.6.3	<i>Audit and Testing</i>	81
5.6.4	<i>Short-Term Thermal Ratings of Power System</i>	81
5.6.5	<i>Partial Outage of Power Protection Systems</i>	81
5.7	<i>POWER SYSTEM STABILITY CO-ORDINATION</i>	81
5.7.1	<i>Stability Analysis Co-ordination</i>	81
5.7.2	<i>Audit and Testing</i>	82
5.8	<i>POWER SYSTEM SECURITY OPERATIONS</i>	82
5.8.1	<i>Users' Advice</i>	82
5.8.2	<i>Protection or Control System Abnormality</i>	82
5.8.3	<i>Western Power's Advice on Power System Emergency Conditions</i>	82
5.8.4	<i>Managing a Power System Contingency Event</i>	82
5.8.5	<i>Managing Electricity Supply Shortfall Events</i>	83

5.8.6	<i>Directions by Western Power Affecting Power System Security</i>	83
5.8.7	<i>Disconnection of Generating Units and/or Associated Loads</i>	84
5.8.8	<i>Emergency Black Start-up Facilities</i>	84
5.8.9	<i>Local Black System Procedures</i>	84
5.8.10	<i>Black System Start-up</i>	84
5.8.11	<i>Review of Operating Incidents</i>	85
5.9	<i>POWER SYSTEM SECURITY RELATED MARKET OPERATIONS</i>	85
5.9.1	<i>Dispatch Related Limitations</i>	85
5.9.2	<i>Commitment of Generating Units</i>	86
5.9.3	<i>De-commitment, or Output Reduction, by Users Requiring Standby Power</i>	86
5.9.4	<i>User Plant Changes</i>	87
5.9.5	<i>Operation, Maintenance and Extension Planning</i>	87
5.10	<i>POWER SYSTEM OPERATING PROCEDURES</i>	87
5.10.1	<i>Power System Operating Procedures</i>	87
5.10.2	<i>Transmission Network Operations</i>	87
5.10.3	<i>Switching of Reactive Power Facilities</i>	87
5.11	<i>POWER SYSTEM SECURITY SUPPORT</i>	88
5.11.1	<i>Remote Control and Monitoring Devices</i>	88
5.11.2	<i>Operational Control and Indication Communication Facilities</i>	88
5.11.3	<i>Power System Voice/Data Operational Communication Facilities</i>	88
5.11.4	<i>Records of Power System Operational Communication</i>	89
5.11.5	<i>Agent Communications</i>	89
5.12	<i>NOMENCLATURE STANDARDS</i>	90
6	<i>METERING</i>	91
6.1	<i>INTRODUCTION</i>	91
6.1.1	<i>Application of the Metering Section</i>	91
6.1.2	<i>Purpose of Metering Section</i>	91
6.1.3	<i>Principles of Metering Section</i>	91
6.2	<i>RESPONSIBILITY FOR METERING INSTALLATION</i>	92
6.2.1	<i>Responsibility of Western Power</i>	92
6.2.2	<i>User Elects to Provide and Install Certain Metering Components</i>	92
6.2.3	<i>Other Responsibilities</i>	93
6.3	<i>METERING INSTALLATION ARRANGEMENTS</i>	93
6.3.1	<i>Metering Installation Components</i>	93
6.3.2	<i>Use of Meters</i>	94
6.3.3	<i>Metering Type and Accuracy</i>	94
6.3.4	<i>Data Collection System</i>	95
6.3.5	<i>Payment for Metering</i>	95

6.4	REGISTER OF METERING INFORMATION	95
6.4.1	Metering Register	95
6.4.2	Meter Register Discrepancy	95
6.5	TESTING OF METERING INSTALLATION	96
6.5.1	Responsibility for Testing	96
6.5.2	Actions in Event of Non-Compliance	96
6.5.3	Audits of Metering Data	96
6.6	RIGHTS OF ACCESS TO DATA	96
6.7	SECURITY OF METERING INSTALLATIONS	97
6.7.1	Security of Metering Equipment	97
6.7.2	Security Controls	97
6.7.3	Changes to Metering Equipment, Parameters and Settings	97
6.8	PROCESSING OF METERING DATA FOR SETTLEMENT PURPOSES	97
6.8.1	Metering Databases	97
6.8.2	Remote Acquisition of Data	97
6.8.3	Periodic Energy Metering	97
6.8.4	Data Validation	98
6.8.5	Errors Found in Metering Tests, Inspections or Audits	98
6.9	CONFIDENTIALITY	98
6.10	METER TIME	98
7.	<i>DEROGATIONS</i>	<i>99</i>
7.1	PURPOSE AND APPLICATION	99
7.2	TRANSMISSION NETWORKS AND FACILITIES EXISTING AT 7 December 2004	99
	<i>ATTACHMENT 1 - GLOSSARY</i>	<i>100</i>
	<i>ATTACHMENT 2 - RULES OF INTERPRETATION</i>	<i>117</i>
	<i>ATTACHMENT 3 - SUMMARY OF SCHEDULES OF TECHNICAL DETAILS TO SUPPORT APPLICATION FOR CONNECTION AND ACCESS AGREEMENT</i>	<i>118</i>
	<i>ATTACHMENT 4 - SCHEDULE S1: GENERATING UNIT DESIGN DATA</i>	<i>120</i>
	<i>ATTACHMENT 5 - SCHEDULE S2: GENERATING UNIT SETTING DATA</i>	<i>126</i>

**ATTACHMENT 6 - SCHEDULE S3: NETWORK AND PLANT TECHNICAL
DATA OF EQUIPMENT AT OR NEAR CONNECTION POINT..... 127**

**ATTACHMENT 7 - SCHEDULE S4: NETWORK PLANT AND APPARATUS
SETTING DATA 129**

**ATTACHMENT 8 - SCHEDULE S5: LOAD CHARACTERISTICS AT
CONNECTION POINT..... 130**

ATTACHMENT 9 - METERING REQUIREMENTS..... 131

**ATTACHMENT 10 - TEST SCHEDULE FOR SPECIFIC PERFORMANCE
VERIFICATION AND MODEL VALIDATION 134**

This page has intentionally been left blank.



1 GENERAL

1.1 AUTHORISATION

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

- (a) performance standards in respect of service quality parameters in relation to the *electricity transmission network*;
- (b) the technical requirements which apply to the design or operation of *plant* or equipment *connected* to the *electricity transmission network*;
- (c) requirements relating to the operation of the *electricity transmission network* (including the operation of the *electricity transmission network* in emergency situations or where there is a possibility of a person suffering injury);
- (d) obligations on *users* to test *plant* or equipment in order to demonstrate compliance with the technical requirements referred to in paragraph (b) and the operational requirements referred to in paragraph (c);
- (e) procedures which apply if *Western Power* believes that a *user’s plant* or equipment does not comply with the requirements of the *Technical Code*;
- (f) procedures relating to the inspection of a *user’s plant* or equipment;
- (g) procedures which apply to system tests carried out in relation to all or a part of the *electricity transmission network*;
- (h) requirements which relate to control and *protection* settings for *plant* or equipment *connected* to the *electricity transmission network*;
- (i) procedures which apply in the case of the commissioning and testing of new *plant* or equipment *connected* to the *electricity transmission network*;
- (j) procedures which apply to the *disconnection* of *plant* or equipment from the *electricity transmission network*;
- (k) procedures relating to the operation of *generating units* and other *plant* or equipment as part of or *connected* to the *electricity transmission network* (including the giving of *dispatch* instructions and compliance with those instructions);
- (l) *metering* requirements in relation to *connections*;

- (m) the information which each *user* is required to provide *Western Power* in relation to the operation of *plant* or equipment *connected* to the *electricity transmission network* at the *user's connections* and how and when that information is to be provided;
- (n) requirements in relation to under *frequency load shedding* with which *users* must comply;
- (o) any other matters relating to the *power system* (including the *electricity transmission network*) or *plant* or equipment *connected* directly or indirectly to the *electricity transmission network*; and
- (p) the *network planning criteria* as required by regulation 27 of the *Regulations*.

1.2 APPLICATION

In this *Technical Code*, unless otherwise stated, a reference to *Western Power* refers to the Networks Business Unit of *Western Power* for the *South West Interconnected System* and refers to Pilbara Branch of *Western Power* for the *North West Interconnected System*. Other business units of *Western Power* are “users” under the *Code*.

- This *Code* applies to:
 - (a) *Western Power* in its role as the operator of the *electricity transmission network*;
 - (b) every person who seeks access to *spare capacity* or *new capacity* or makes an *access application* under the *Regulations* in order to establish a *connection* or modify an existing *connection*;
 - (c) every person to whom access to electricity transmission capacity is made available (including, without limitation, *Western Power* in its role as a trader of electricity and every person with whom *Western Power* has entered into an *access agreement*); and
 - (d) the *Electricity Referee*.
- This *Code* applies to all *plant* and equipment installed:
 - (a) in the *Western Power electricity transmission networks*; and
 - (b) by *users* who are *connected* (either directly or indirectly) to the *electricity transmission networks*, and who impact on the operation and security of the *electricity transmission networks*, including *embedded generators*.

1.3 COMMENCEMENT

This Version 2 of the *Code* comes into operation on **7 December 2004** (“*Code commencement date*”).

1.4 INTERPRETATION

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

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

1.5 DISPUTE RESOLUTION

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

1.6 OBLIGATIONS

1.6.1 Obligations of *Users*

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

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

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

1.6.2 Obligations of *Western Power*

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

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

(b) *Western Power* must:

- (1) ensure that to the extent that a *connection point* relates to the *electricity transmission network*, every arrangement for *connection* with a *User* complies with all relevant provisions of this *Code*;

- (2) permit and participate in inspection and testing of *facilities* and equipment in accordance with clause 4.1;
 - (3) permit and participate in commissioning of *facilities* and equipment which is to be *connected* to its *network* in accordance with clause 4.2;
 - (4) advise a *User* with whom there is an *access agreement* of any expected interruption characteristics at a *connection point* on or with its *network* so that the *User* may make alternative arrangements for *supply* during such interruptions, including negotiating for an alternative or backup *connection*; and
 - (5) use its reasonable endeavours to ensure that modelling data used for planning, design and operational purposes is complete and accurate and order tests in accordance with clause 4.1 where there are reasonable grounds to question the validity of data.
- (c) *Western Power* must arrange for:
- (1) management, maintenance and operation of the *electricity transmission networks* such that in the *satisfactory operating state*, electricity may be transferred continuously at a *connection point* up to the *agreed capability*;
 - (2) management, maintenance and operation of its *networks* to minimise the number and impact of interruptions to the *User* through adequate notification and consultation by using *good electricity industry practice*; and
 - (3) restoration of the *agreed capability* as soon as reasonably practicable following any interruption at a *connection point* on or with its *network*.

1.6.3 Obligations of Users with Loads

- (a) Each *User* with a *load* must ensure that all *facilities* which are owned, operated or controlled by it and are associated with a *connection point* at all times comply with applicable requirements and conditions of *connection* for *loads*:
- (1) as set out in clause 3.3; and
 - (2) in accordance with any *access agreement* with *Western Power*.
- (b) A *User* with a *load* must:
- (1) comply with the reasonable requirements of *Western Power* in respect of design requirements of equipment proposed to be *connected* in accordance with clause 3.3;
 - (2) permit and participate in inspection and testing of *facilities* and equipment in accordance with clause 4.1;
 - (3) permit and participate in commissioning of *facilities* and equipment which is to be *connected* to a *network* location for the first time in accordance with clause 4.2;
 - (4) operate its *facilities* and equipment in accordance with any reasonable *direction* given by *Western Power*; and
 - (5) give notice of any intended voluntary *disconnection* in accordance with clause 4.3.

1.6.4 Obligations of *Generators*

- (a) A *Generator* must comply at all times with applicable requirements and conditions of *connection* for *generating units*:
 - (1) as set out in clause 3.2; and
 - (2) in accordance with any *access agreement* with *Western Power*.
- (b) Each *Generator* must:
 - (1) comply with the reasonable requirements of *Western Power* in respect of design requirements of equipment proposed to be *connected* to the *network* of *Western Power* in accordance with clause 3.2;
 - (2) permit and participate in inspection and testing of *facilities* and equipment in accordance with clause 4.1;
 - (3) permit and participate in commissioning of *facilities* and equipment which is to be *connected* to a *network* location for the first time in accordance with clause 4.2;
 - (4) operate *facilities* and equipment in accordance with any reasonable *direction* given by *Western Power*; and
 - (5) give notice of intended voluntary *disconnection* in accordance with clause 4.3.

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

1.7.1 Variations and Exemptions to the Code

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

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

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

1.7.2 Amendments to the Code

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

2. TRANSMISSION NETWORK PERFORMANCE AND PLANNING CRITERIA

2.1 INTRODUCTION

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

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

Prior to a *User's facilities* being *connected* to the *power system*, the impact on *power system* performance due to the *User's facilities* is to be determined by *power system* simulation studies as specified by *Western Power*. These studies may be performed by the *User* or a third party, in which case, *Western Power* will require full details of the studies performed, including, assumptions made, results, conclusions and recommendations. However, acceptance of the studies performed by a *User* or a third party will be entirely at *Western Power's* discretion. Acceptance of *power system* studies by *Western Power* does not absolve *Users* of responsibility/liability for damages or losses incurred by others. *Western Power* reserves the right to perform its own studies (at the *User's* cost) and will provide details of such studies to the *User*. *Western Power* will make the final determination on the suitability of a *User's facilities* and the requirements to be fulfilled prior to and after the *facilities* are *connected*, in accordance with the *Regulations* and this *Code*.

2.2 POWER QUALITY

2.2.1 Frequency Variations

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

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

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

Table 2.1 Western Power's Frequency Operating Standards for SWIS. For NWIS, refer to the Operating Protocol No. 2.05.

Condition	Frequency Band	Target Recovery Time
No disturbance:		
South West	49.8 to 50.2 Hz for 99% of time	-
Island ⁽¹⁾	49.5 to 50.5 Hz	-

Single contingency ⁽²⁾	48.75 to 51 Hz	49.8 to 50.2 Hz within 25 minutes For over-frequency events: 51.0 to 50.5 Hz within 2 minutes
Multiple Contingency	47.0 to 52.0 Hz	49. 8 to 50.2 Hz within 25 minutes For under-frequency events: 47.0 to 47.5 Hz within 10 seconds 47.5 to 48.0 Hz within 5 minutes 48.0 to 48.5 Hz within 15 minutes For over-frequency events: 52.0 to 51.5 Hz within 1 minute 51.5 to 51.0 Hz within 2 minutes 51.0 to 50.5 Hz within 5 minute

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

(2) – 48.75 Hz corresponds to the first stage of underfrequency load shedding (see clause 2.4).

Western Power will require the use of load shedding facilities (described in clause 2.4 in this section) to aid recovery of frequency to the range 49.5Hz to 50.5Hz. Frequency tolerance limits must be satisfied under the worst credible power system load and generation pattern, and the most severe credible contingencies of transmission plant including the loss of interconnecting plant leading to the formation of credible islands within the power system. Even with the formation of islands, each island in the power system, which contains generation, must have sufficient load shedding facilities in accordance with clause 2.4 to aid recovery of frequency to the range 49.5Hz to 50.5Hz.

2.2.2 Power Frequency Voltage Variations

Western Power must plan and design *extensions* of its *networks* and equipment for control of *voltage* such that the minimum steady state *voltage* on the *transmission network* will be 90% of nominal *voltage* and the maximum steady state *voltage* will be 110% of nominal *voltage*. However, in some parts of the system other limits may be applied following detailed *load-flow*, *fault*, *harmonics*. and *stability studies*. clause 2.6.1,

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

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

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

2.2.3 Voltage Fluctuations

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

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

The flicker severity is characterised by two quantities:

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

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

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

Table 2.2 Transmission Planning Levels for Flicker Severity

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

Notes:

1. *These values were chosen on the assumption that the transfer coefficients between MV or HV systems and LV systems is unity;*
2. *The planning levels in Table 2.2 are not intended to control flicker arising from uncontrollable events such as faults in the power system, etc.*

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

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

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

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

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

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

- (a) *automatic access standard*: Western Power must allocate emission limits no more onerous than the lesser of acceptance levels determined in accordance with either of the stage 1 or the stage 2 evaluation procedures defined in AS/ANZ 61000.3.7:2001; and
- (b) *minimum access standard*: the determination by Western Power of acceptable emission limits must be undertaken in consultation with the party seeking *connection* using the stage 3 evaluation procedure defined in AS/ANZ 61000.3.7:2001.

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

2.2.4 Voltage Waveform Distortion

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

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

Table 2.3 Transmission planning levels for harmonic voltage in networks with system voltage less or equal 35kV (in percent of the nominal voltage)

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

Table 2.4 Transmission planning levels for harmonic voltage in networks with system voltage above 35kV (in percent of the nominal voltage)

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

Notes:

1. The planning levels in Tables 2.3 & 2.4 are not intended to control harmonics arising from uncontrollable events such as geomagnetic storms, etc.
2. The total harmonic distortion (THD) is calculated from the expression

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

where



U_{nom} - nominal voltage of a system;

U_1 - fundamental voltage;

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

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

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

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

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

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

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

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

- (c) *automatic access standard*: Western Power must allocate emission limits no more onerous than the lesser of acceptance levels determined in accordance with either of the stage 1 or the stage 2 evaluation procedures defined in AS/ANZ 61000.3.6:2001; and
- (d) *minimum access standard*: the determination by Western Power of acceptable emission limits must be undertaken in consultation with the party seeking *connection* using the stage 3 evaluation procedure defined in AS/ANZ 61000.3.6:2001.

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

2.2.5 Voltage Unbalance

Western Power must balance the phases of its network and User must balance the current drawn in each phase at each of its connection points so as to achieve average levels of

negative sequence voltage at all connection points that are equal to or less than the values set out in Table 2.5 below.

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

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

Table 2.5 Transmission limits for negative phase sequence component of voltage (in percent of the positive phase sequence component)

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

Note:

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

Measurements of negative sequence voltage should be carried out with a minimum duration of one week.

The maximum weekly value of the 10 minute averages of negative sequence voltage should not exceed the limits;

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

2.2.6 Electromagnetic Interference

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

2.2.7 Assessment of Power Quality

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

Table 2.6 Power quality parameters measurement.

Parameter	Value measured	Frequency of measurement	Minimum measurement period	Data sampling interval
Fundamental Frequency	mean value over interval	Continuous	all the time	10 seconds
Power-frequency voltage magnitude	mean rms value over interval	Periodically	one week	10 minutes
Short-term flicker severity	P_{st}	Periodically	one week	10 minutes
Long-term flicker severity	P_{lt}	Periodically	one week	2 hours
Harmonic / interharmonic voltage and voltage THD	mean rms value over interval	Periodically	one week	10 minutes
Negative sequence voltage	mean rms value over interval	Periodically	one week	10 minutes

Notes:

1. *The power quality parameters except fundamental frequency and negative sequence voltage are to be measured in each phase of a three-phase system;*
2. *The fundamental frequency is measured based on line-to neutral voltage in one of the phases or line-to-line voltage between two phases;*
3. *Other parameters, and data sampling intervals can be used to assess Western Power's network and User system performance during specific events.*

2.3 STABILITY

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

Power system stability is the ability of an electric power system, for a given initial operating condition, to regain a state of operating equilibrium after being subjected to a physical

disturbance, with most system variables bounded so that practically the entire system remains intact.

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

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

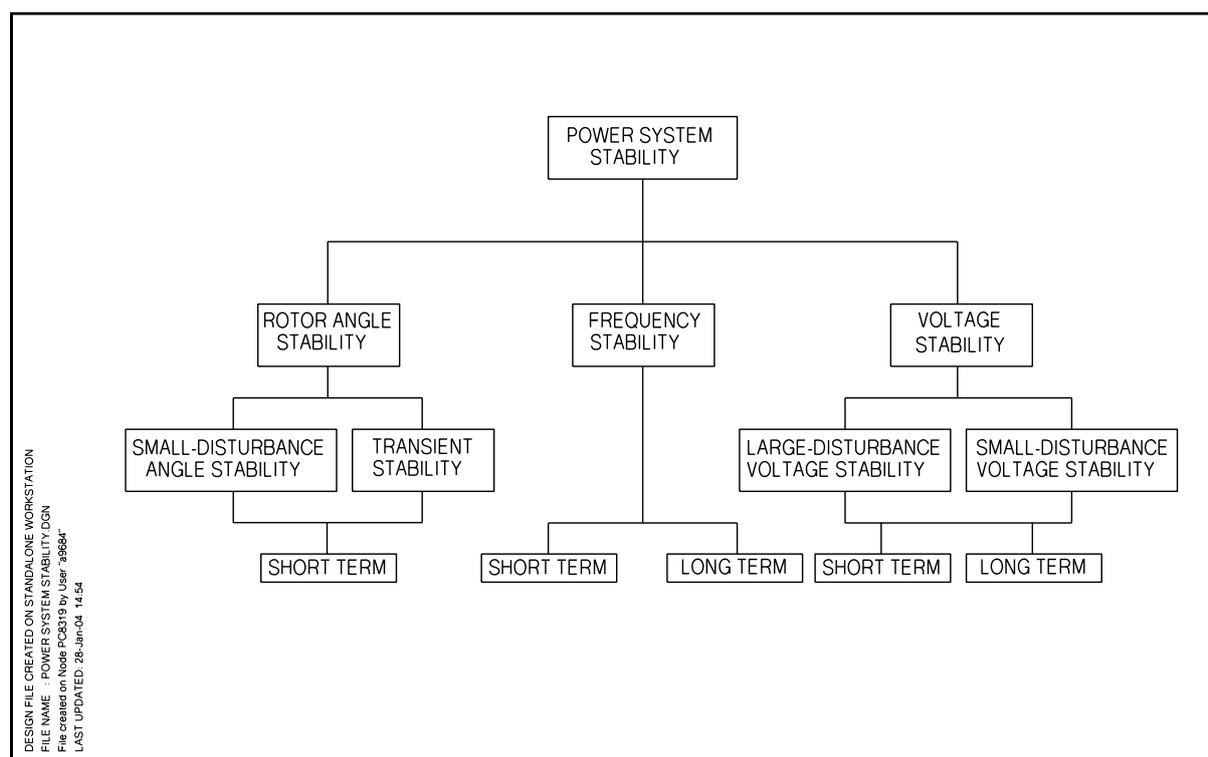


Figure 2.0 – Classification of power system stability.

2.3.1 Rotor Angle Stability

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

Small-disturbance (or small-signal) rotor angle stability is the ability of the power system to maintain synchronism under small disturbances. The disturbances are considered to be sufficiently small if linearization of system equations is permissible for purposes of analysis.

Small disturbances may be caused by routine switching (for example, line or capacitor), transformer tap changes, generator AVR setpoint changes, etc.

Large-disturbance rotor angle stability or transient stability is the ability of the power system to maintain synchronism when subjected to severe disturbances, for example a short circuit on a nearby transmission line. The resulting system response involves large excursions of generator rotor angles and is influenced by the non-linear power-angle relationship.

The rotor angle stability criterion is:

All generators connected to the power system shall remain in synchronism without pole-slipping.

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

System disturbances are as specified in clause 2.3.4.1.

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

- 1) All transmission and distribution network faults must be cleared rotor angle within the critical fault clearance time.
- 2) The level of power transfer must not exceed 95% of the rotor angle stability transfer limit required to ensure that the system is stable.

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

2.3.1.1 Damping of Power System Oscillations

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

- | |
|---|
| <ul style="list-style-type: none">a) The damping ratio of the oscillations should be at least 0.1.b) For electro-mechanical oscillations as a result of small disturbances, the damping ratio of the oscillation should be at least 0.5.c) In addition to a) and b), the halving time of any oscillations shall not exceed 5 seconds. |
|---|

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

2.3.2 Frequency Stability

Frequency stability is the ability of a power system to maintain steady frequency following a severe system disturbance resulting in a severe imbalance between generation and load. Instability that may result occurs in the form of sustained frequency swings leading to tripping of generating units and/or loads.

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

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

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

2.3.3 Voltage Stability

Voltage stability is the ability of a power system to maintain steady voltages at all busses in the system after being subjected to a disturbance from a given operating condition. Instability that may result occurs in the form of a progressive fall or rise of voltages at some busses. A possible outcome of voltage instability is loss of load in the area, or tripping of transmission lines and other elements, including generators, by their protective systems leading to cascading outages.

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

2.3.3.1 Voltage Stability Criterion

All necessary steps should be taken to ensure that:

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

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

2.3.3.2 Temporary Over-Voltages

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

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

2.3.3.3 Transient Over-Voltages

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

2.3.3.4 Transient Voltage Dip Criteria (TVD)

The transient voltage dip limits are as follows.

- a) In the metropolitan area, system transient voltages dips resulting from the power swings that follows a fault, should not drop below 75% of nominal operating voltage and shall not remain below 80% of nominal operating voltage for more than 400ms during the power swing.
- b) In all country and remote areas, system transient voltages dips resulting from the power swings that follows a fault, should not drop below 70% of nominal operating voltage and shall not remain below 80% of nominal operating voltage for more than 800ms during the power swing.
- c) In all metropolitan and country areas the post-transient voltage deviation limits shall be in accordance with the values specified in Table 2.10

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

Due consideration must be given to the Transient Voltage Dip limits to prevent motor loads

being disconnected from the system by the undervoltage resulting from transient power swings.

2.3.3.5 Post-Fault Voltage Recovery Limit

- a) In the metropolitan area, transmission system voltages after a fault on the system is cleared shall recover to levels above 80% of nominal operating voltage within 400ms counting from the end of the fault clearance.
- b) In all country and remote areas, transmission system voltages after a fault on the system is cleared shall recover to levels above 80% of nominal operating voltage within 800ms counting from the end of the fault clearance.

Refer to Figure 2.3 for further details.

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

2.3.4 Stability Assessment

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

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

- a) A single credible contingency event consistent with the N-1 criterion of clause 2.5;
- b) A double credible contingency event consistent with the N-2 criterion of clause 2.

These contingency events involve fault types as-specified in clause 2.3.4.1.

2.3.4.1 Fault Types to be Studied

The most severe disturbance that can occur at any location within the power system from the following fault types is to be used to determine the stability of the power system:

- 1) A three-phase-to-earth fault cleared by disconnection of the faulted component;
- 2) A single-phase-to-earth fault cleared by backup protection and the disconnection of the

faulted component;

- 3) A single-phase-to-earth fault cleared, but after unsuccessful high-speed single-phase auto-reclosure onto persistent fault;
- 4) Sudden disconnection of a system component, e.g. a transmission line, a generation unit.

In each case, the slower of the two main protection operating schemes should be used as the fault clearance time to determine the stability of the power system.



Highest Acceptable Level and Duration
of AC Temporary Overvoltage

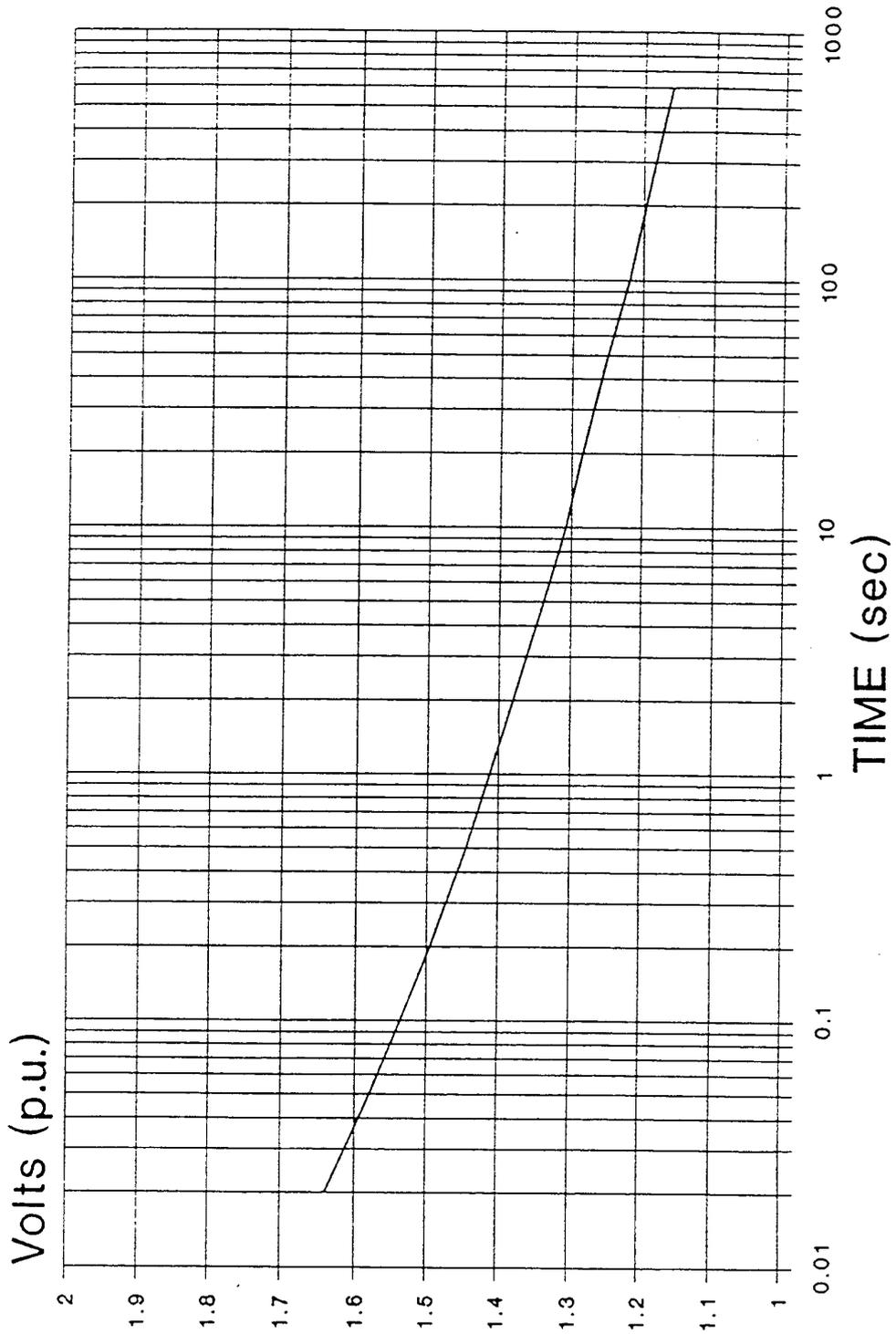


Figure 2.1 - Highest Acceptable Level and Duration of AC Temporary Over-Voltage

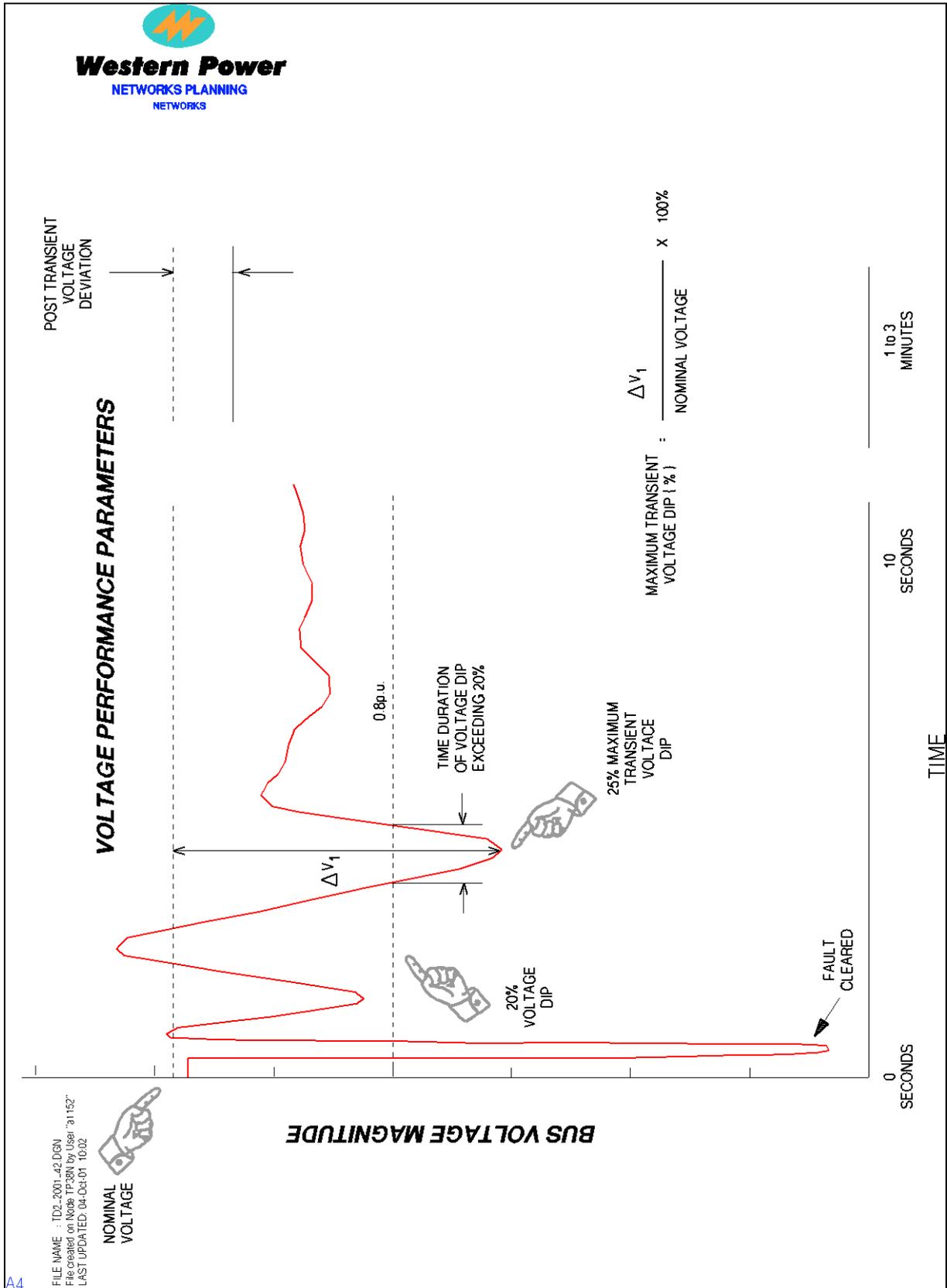


Figure 2.2. Transient voltage dip (TVD) criteria.

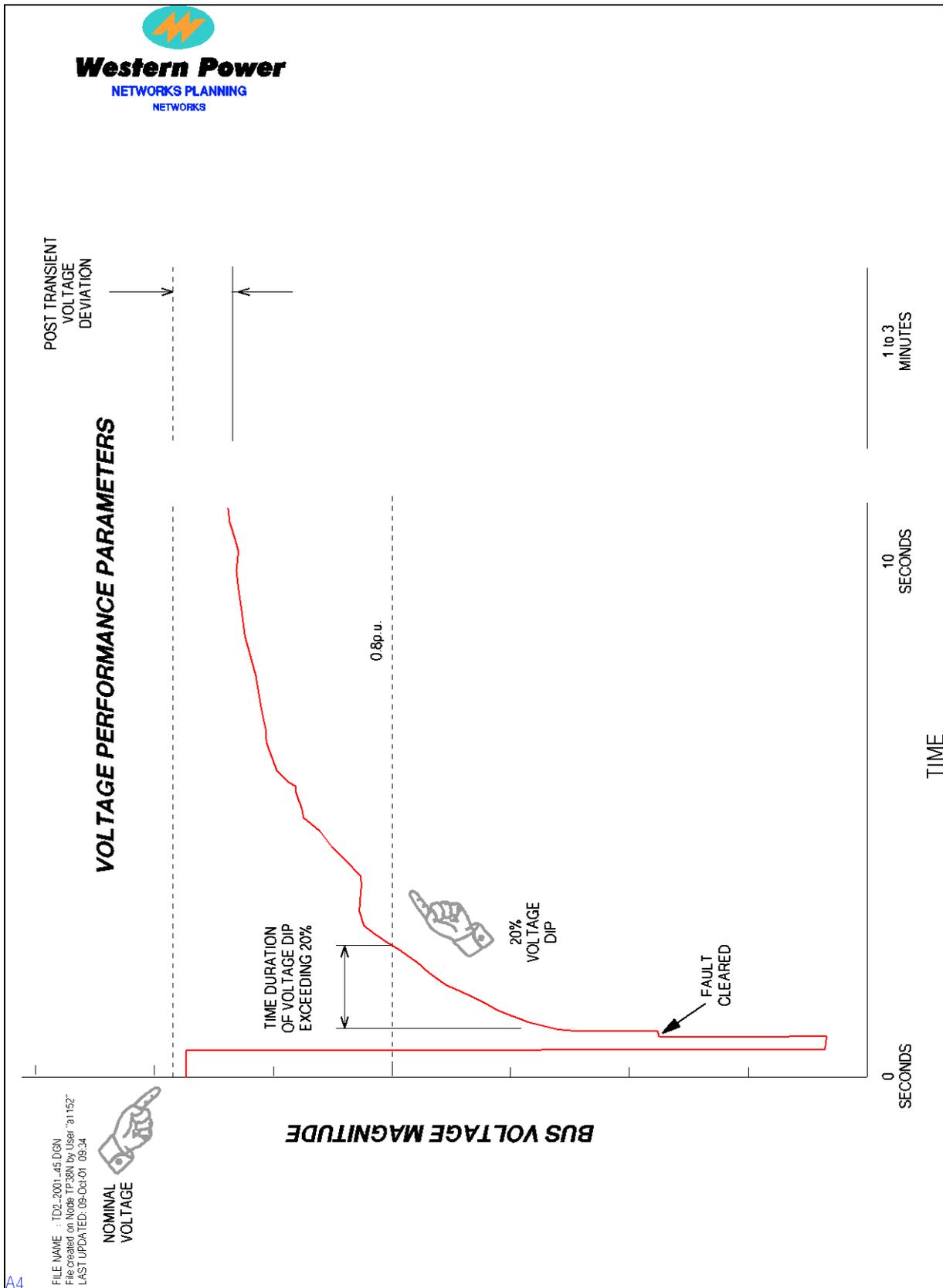


Figure 2.3 Transient voltage recovery (TVR) limits.

2.4 LOAD SHEDDING FACILITIES

It is a requirement that no single credible disturbance, for example tripping of any generator, shall initiate underfrequency load shedding, other than the designated interruptable load, in the SWIS.

2.4.1 *Load to be Available for Disconnection*

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

- (a) under the automatic control of *underfrequency* relays; and
- (b) under manual or automatic control from *control centres*; and/or
- (c) under the automatic control of *undervoltage* relays.

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

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

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

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

2.4.2 *Installation and Testing of Load Shedding Facilities*

Users must:

- (a) provide, install, operate and maintain *facilities* for *load shedding* in respect of any *connection point*.
- (b) co-operate with *Western Power* in conducting periodic functional testing of the *facilities*, which must not require *load* to be *disconnected*, provided *facilities* are available to test the scheme without shedding *load*.
- (c) apply *underfrequency* settings to relays as determined by *Western Power*.
- (d) apply *undervoltage* settings to relays as determined by *Western Power*.

2.4.3 Existing Settings of Under-Frequency Load Shedding Schemes

The present settings for the *South West Interconnected System* under-frequency load shedding scheme are given in Table 2.7. and for the *North West Interconnected System* under-frequency load shedding scheme are given in Table 2.8. The UFLS requirement and the settings specified in Table 2.7 are fully applicable to all User's loads as long as the User's system, including its generation, is connected to the Western Power network.

Switchable capacitor banks at substations should also be shed in accordance with Table 2.7.

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

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

Table 2.8
Under Frequency Load Shedding Scheme Settings for the North West Interconnected System

Stage	Freq. (Hz)	Time Delay (sec)	Load Shed (%)	Capacitor Shed (%)
1	49.00	0.5	17	17
2	48.75	0.5	17	17

2.5 RELIABILITY OF THE TRANSMISSION NETWORK

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

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

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

- N-0,
- N-1 or,
- N-2.

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

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

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

In general the bulk *transmission network* which interconnects the major *power stations* with the *transmission substations* will be designed to the N-2 criteria. The remainder of the *network* will be designed to the N-1 criteria with the exception of radial feeds to remote *power system loads* which are normally designed to the N-0 criteria.

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

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

The N-1 criterion is applied to all sub-networks with a peak load exceeding 20 MW, with the exception of the 220kV network supplying the Eastern Goldfields Region.

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

The N-1 contingency criterion applies to:

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

For the *sub-network* designed to operate with the N-2 criterion the *network* must be capable of withstanding coincident planned and unplanned *outages* of *transmission elements* listed in Table 2.9 at up to 80% of *peak load*.

It is to be assumed that during the planned *outage*, generation has been rescheduled to mitigate the effect of the subsequent *outage*.

The N-2 contingency criterion applies to:

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

Table 2.9 Combinations of Transmission Elements Comprising a Double-Contingency (N-2 Criterion)

N-2 Outages
<i>transmission</i> line maintenance and <i>transmission</i> line
<i>Transformer</i> maintenance and <i>transformer</i>
<i>transformer</i> maintenance and <i>transmission</i> line
<i>busbar</i> maintenance and <i>transmission</i> line
<i>busbar</i> maintenance and <i>transformer</i>
circuit breaker maintenance and <i>transmission</i> line
circuit breaker maintenance and <i>transformer</i>
circuit breaker maintenance and <i>busbar</i> loss
<i>transmission</i> line maintenance and <i>transformer</i>

The N-2 criterion is applied to:

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

2.5.1 Stuck Breaker Criterion

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

2.6 STEADY STATE CRITERIA

Each of the steady state criteria should be satisfied for the contingency criteria in clause 2.8 2.5 of this *Code* (N-1 and N-2 criteria):

2.6.1 Steady State Voltage Limits

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

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

Table 2.10
Step - Change Voltage Limits

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

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

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

2.6.2 Thermal Limits

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

- 1) *Transformers*: Normal cyclic rating as defined by IEC 354.
- 2) *Switchgear*: Normal manufacturer's name plate rating.
- 3) *Lines*: Summer or winter continuous ratings appropriate for the season based on:
 - a) ambient temperature being that for 1% probability of daily maximum temperature not being exceeded over the summer season (December to February), and 25°C for winter;
 - b) wind speed being 1.0m/s;
 - c) solar radiation being 1000W/m² (weathered surface); and
 - d) conductor design clearance temperature as defined in ESAA Code C(b)1.

2.6.3 Fault Limits

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

2.6.4 Generating Limits

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

2.6.5 Reactive Planning Process

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

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

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

2.7 SAFETY CRITERIA

As part of the planning process the safety risk should be considered for any new developments and existing *facilities* which may have a significant impact on safety. The safety risk is to be assessed in the planning process. Relevant bodies should be informed, consulted and steps taken to ensure safety is maintained to industry standards and statutory requirements.

2.8 ENVIRONMENTAL CRITERIA

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

2.8.1 Social Issues

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

2.8.2 Land-use Considerations

Due consideration shall be given to avoid the use of land where there is a potential for conflict in usage.

3. TECHNICAL REQUIREMENTS OF *USER FACILITIES*

3.1 INTRODUCTION

This Section sets out details of the technical requirements which *Users* must satisfy as a condition of *connection* of any *plant* and equipment to the *power system* (including *embedded generators*), except where specifically varied in an *access agreement*.

3.2 REQUIREMENTS FOR *CONNECTION OF GENERATORS*

Western Power will carry out detailed *power system* studies to determine performance requirements to be expected from a proposed new *generating unit* or modification to an existing *generating unit*. All costs associated with these studies, including studies to obtain any necessary optimal settings for the *generating unit* and its controls shall be borne by the *User*. The *User* shall be responsible for all costs associated with the installation, performance verification, parameter tuning and model validation of any additional equipment identified in the studies.

Users will be responsible for ensuring that *plant* capabilities and ratings are monitored on an ongoing basis to ensure continued suitability as conditions on the *power system* change in the future (e.g. increasing fault levels as additional *plant* is *connected* to the *power system*). A *User* will be responsible for the cost of any *plant* upgrades required at its *facilities* as a result of changing *power system* conditions.

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

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

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

- (1) not cause any reduction of inter-regional or intra-regional power transfer capability because of:
 - (i) rotor angle stability,
 - (ii) frequency stability, or
 - (iii) voltage stabilityby more than its loading level whenever it is synchronised / connected relative to the level that would apply if the generating unit were disconnected;
- (2) not cause instability that would adversely impact other *Users*.

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

A windfarm with induction generators should not draw excessive amounts of reactive power from the grid while reaccelerating that would adversely impact other Users or the TNSP.

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

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

- (i) Rate-of-change-of frequency
- (ii) Magnitude of frequency excursion
- (iii) Active power imbalance
- (iv) Reactive power imbalance
- (v) Displacement of reactive capability

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

3.2.1 Technical Characteristics

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

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

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

- b) The requirements to ensure stability of the *electricity transmission network* and maintain *power transfer capabilities* may have an impact on the generator, step-up transformer, turbine, inertia constant, turbine control or excitation system, etc, of the synchronous/induction generating unit or the control system characteristics/behaviour for an inverter or converter coupled generating unit.
- c) All generating units, synchronous or otherwise, must provide voltage control within own reactive power capability of clause 3.2.4.1, as per the applicable control strategy, limits and range set out in clause 3.2.5.4.

3.2.2 Technical Matters to be Co-ordinated

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

- a) Design at *connection point*;
- b) Physical layout adjacent to *connection point*;
- c) *Protection* and backup;
- d) Control characteristics;
- e) Communications, *metered* quantities and alarms;
- f) Insulation co-ordination and lightning protection;
- g) Fault levels and fault clearing times;
- h) Switching and *isolation facilities*;

- i) Interlocking arrangements;
- j) *Metering installations* as described in Section 6;
- k) *synchronising facilities*;
- l) *under frequency load shedding* and islanding schemes; and
- m) any special test requirements.

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

3.2.3 Provision of Information

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

3.2.4 Detailed Technical Requirements Requiring Ongoing Verification

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

3.2.4.1 Reactive Power Capability

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

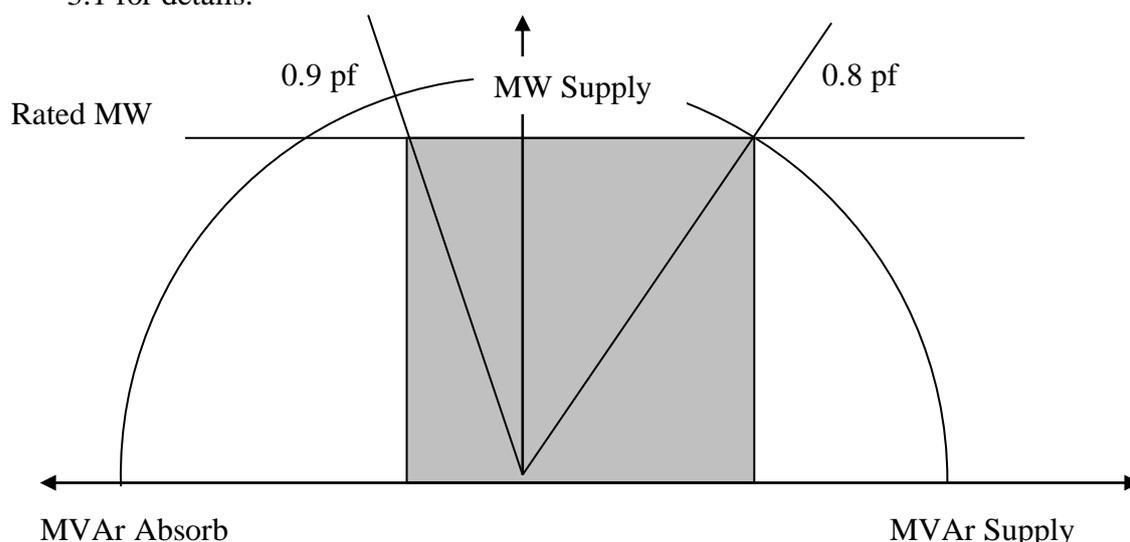


Figure 3.1 Synchronous Generating Unit Reactive Power Capability Requirements at Generator Terminals shown Shaded

- (2) Each *induction generating unit* must be capable of *supplying a reactive power* output coincident with rated real power output such that at the *connection point* to

the *network at nominal voltage* the lagging *power factor* is less than or equal to 0.95 and at the same power output the *generating unit* must be capable of absorbing *reactive power* at a leading *power factor* less than or equal to 0.95. In some circumstances, a larger *power factor* range may be required. This will be determined by *power system* simulation studies. *Users* will be advised accordingly of any additional requirements. Refer to Figure 3.2 for details.

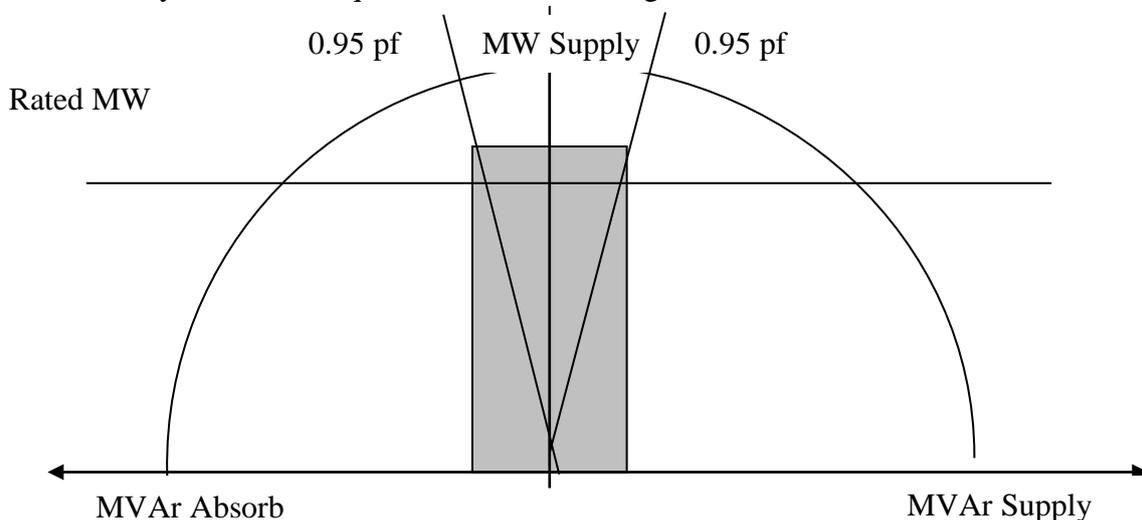


Figure 3.2 Induction Generating Unit Reactive Capability Requirements at Point of Common Coupling shown Shaded

- (3) Each *inverter or converter coupled generating unit* shall be capable of supplying a reactive power such that at the inverter or converter connection point to the network at nominal voltage the lagging *power factor* is less than or equal to 0.95 and shall be capable of absorbing reactive power at a leading *power factor* less than or equal to 0.95. Refer to Figure 3.3 for details.
- (4) For generators for not described by subsections (1), (2) or (3), the *power factor* requirements shall be as advised by Western Power.

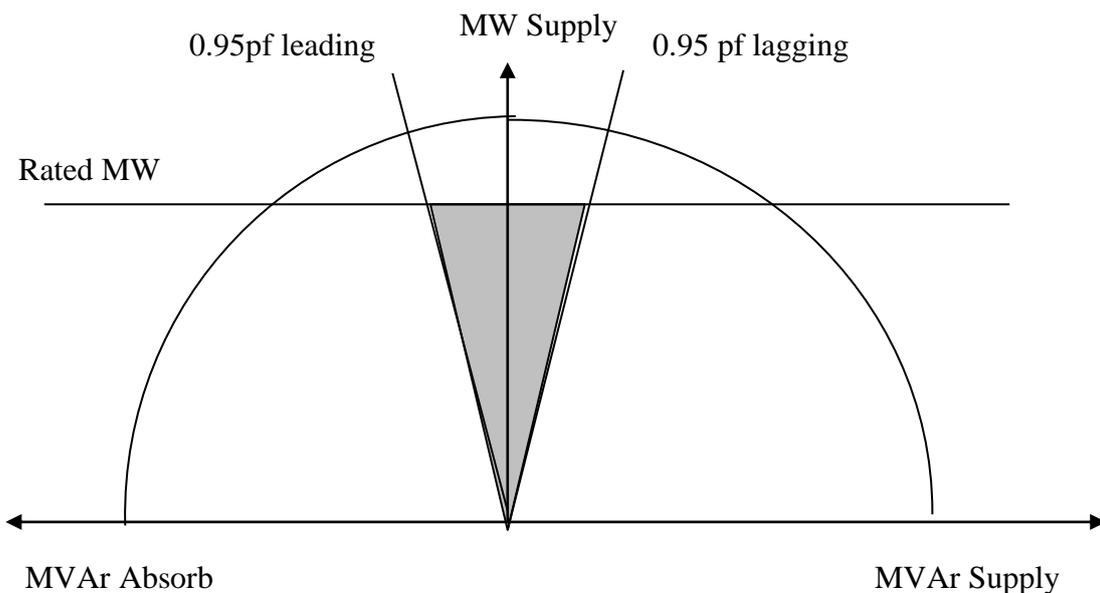


Figure 3.3 Inverter Coupled or Converter Coupled Generating Unit Reactive Capability Requirements at Point of Common Coupling shown Shaded

- (b) In the event that the *power factor* capabilities specified in (a)(1) and (a)(2), as applicable, cannot be provided, the *User* must reach a commercial arrangement under the *access agreement* with *Western Power* for the *supply* of the deficit in *reactive power* as measured at the *generating unit's* terminals.
- (c) The *Generator connection* must be designed to permit the *dispatch* of the full *active power* and *reactive power capability* of the installation as specified in the *access agreement* under all *power system* conditions contained in Section 2 of this *Code*.

3.2.4.2 Quality of Electricity Generated

When operating *unsynchronised*, a *synchronous generating unit* must *generate* a constant *voltage* level with balanced phase *voltages* and harmonic *voltage* distortion equal to or less than permitted in accordance with either *Australian Standard AS 1359 "General Requirements for Rotating Electrical Machines"* or a recognised relevant international standard, as agreed between *Western Power* and the *User*.

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

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

The following are design requirements for *generating units and their auxiliary* systems for continuous uninterrupted operation while being subjected to off-nominal frequency and voltage excursions. The *continuous uninterrupted operation* is defined at the end of this clause. *Network* performance requirements are detailed in Section 2 of this *Code*.

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

The minimum duration of operation at *frequencies* outside the range 47.5 to 52 Hz for the *South West Interconnected System*, and the *North West Interconnected System*, shall be in accordance with Figure 3.4. Operation for a period of at least 20 seconds is required each time the frequency is below 47.5 Hz. Operation for a period of at least 6 seconds is required each time the frequency is above 52 Hz.

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

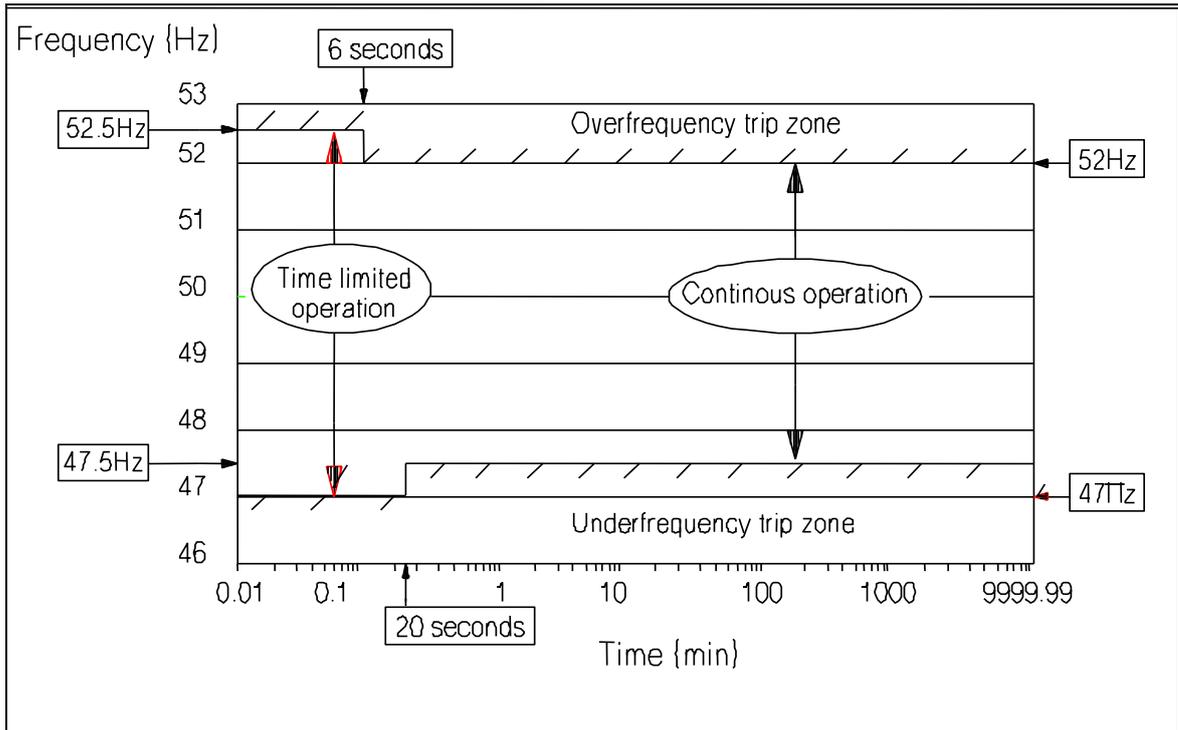


Figure 3.4 – Off Nominal Frequency Operation Capability Requirement for Generators

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

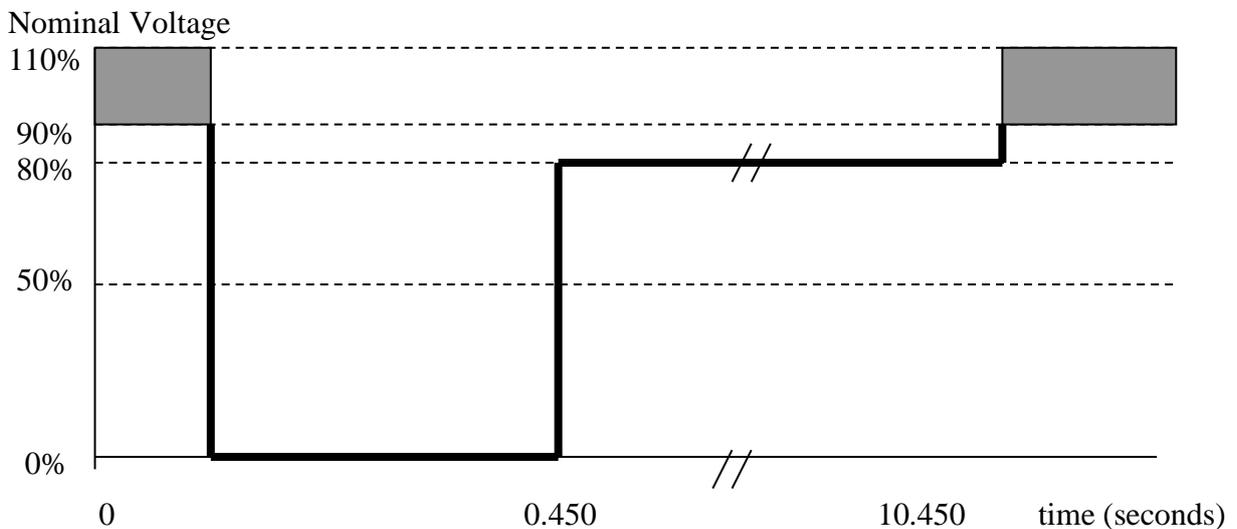


Figure 3.5 – Off Nominal Voltage Operation Capability Requirement for Generators that complement those of Figure 2.1

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

Continuous uninterrupted operation.

For the purpose of this clause 3.2.4.3 *continuous uninterrupted operation* shall mean other than disconnection due to protection operation 3.2.4.3.

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

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

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

3.2.4.4 Partial Load Rejection

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

3.2.4.5 Loading Rates

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

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

3.2.4.6 Safe Shutdown without External Electricity Supply

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

3.2.4.7 Restart following Restoration of External Electricity Supply

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

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

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

3.2.4.8 Protection of Generating Units from Power System Disturbances

- (a) A *generating unit* must be automatically *disconnected* from the *power system* in response to conditions at the relevant *connection point* which are not within the agreed engineering limits for operating the *generating unit* or where the conditions may impact on other *Users*. These abnormal conditions will include and are not necessarily limited to:
 - (1) loss of *synchronism* (*Out-of-step protection/pole-slip protection* may need to be located on the *transmission network*; this should be determined by performing *power system* simulation studies);
 - (2) sustained high or low *frequency* outside the *power system frequency* range 47.5Hz to 52Hz - refer to clause 2.2.1;
 - (3) sustained excessive *generating unit* stator current that cannot be automatically controlled;
 - (4) excessive high or low stator *voltage*;
 - (5) excessive *voltage* to *frequency* ratio;
 - (6) excessive negative phase sequence current;
 - (7) loss of excitation;
 - (8) reverse power, and
 - (9) isolated operation of non-scheduled generation types to avoid uncontrolled supply of local loads.
- (b) The actual settings of the *protection* equipment installed on a *generating unit* determined by the *User* to satisfy requirement (a) must be consistent with *power system* performance requirements specified in Section 2 and must be approved by *Western Power* in respect of their potential to reduce *power system security*. They must be such as to maximise *plant* availability, to assist the control of the *power system* under emergency conditions and to minimise the risk of inadvertent *disconnection* consistent with the requirements of *plant* safety and durability.

Western Power shall bear no responsibility for any loss or damage incurred by the

User as a result of a fault on either the *power system*, the *User's facility* or within the *generating unit* itself.

3.2.4.9 User Protection Systems that Impact on Power System Security

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

3.2.4.10 Generator Transformer Tapping

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

3.2.4.11 Tripping of Generating Units and Associated Loads

Unless otherwise agreed by *Western Power*, the tripping of a *User's generating unit* which is connected to the *transmission network* will require the intertripping of *associated loads* within 0.2 seconds, except where the *User* has contracted for the provision of *standby power*.

3.2.5 Monitoring and Control Requirements

3.2.5.1 Remote Monitoring

Western Power will require the *User* to:

- I. provide *remote monitoring equipment* ("*RME*") to enable *Western Power* to remotely monitor performance of a *generating unit* (including its *dynamic performance*) where this is reasonably necessary in real time for control, planning or security of the *power system*; and
- II. upgrade, modify or replace any *RME* already installed in a *power station* provided that the existing *RME* is, in the reasonable opinion of *Western Power*, no longer fit for purpose and notice is given in writing to the relevant *User*.

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

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

(a) Status Indications

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

(b) Alarms



- (1) *generating unit* circuit breaker tripped by *protection*
 - (2) prepare to off *load*
 - (3) *protection* defective alarms
- (c) Measured Values
- (1) Gross *active power* output of each *generating unit*
 - (2) Net station *active power* import or export at each *connection point*
 - (3) Gross *reactive power* output of each *generating unit*
 - (4) Net station *reactive power* import or export at each *connection point*
 - (5) *Generating unit* stator voltage
 - (6) *Generating unit* transformer tap position
 - (7) Net station output of *active energy* (impulse)
 - (8) *Generating unit* remote *generation* control high limit value
 - (9) *Generating unit* remote *generation* control low limit value
 - (10) *Generating unit* remote *generation* control rate limit value
- (d) Such other input information reasonably required by *Western Power*.
- (e) Control Facilities (typically for unmanned sites)
- (1) *Generating unit* remote generation Stop Initiate
 - (2) *Generating unit* remote generation Start Initiate
 - (3) *Generating unit* remote generation Active Power setpoint
 - (4) *Generating unit* remote generation Reactive Power setpoint
 - (5) *Generating unit* remote generation Generator Step-Up transformer Tap Position

3.2.5.2 Communications Equipment

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

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

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

(a) Primary Speech Facility

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

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

(b) Back-up Speech Facility

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

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

3.2.5.3 Turbine Control System

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

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

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

Deadband

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

Control Range

For Dispatchable generating units

Overall response of a *generating unit* for *power system frequency* excursions must be settable and be capable of achieving an increase in the *generating unit's active power* output of up to 5% for a 0.1 Hz reduction in *power system frequency* for any initial output up to 85% of rated output and a reduction in the *generating unit's active power* output of up to 5% for a 0.1 Hz increase in *system frequency* provided the latter does not require operation below technical minimum. For initial outputs above 85% of rated output, response capability must be included in the *access agreement*, and the *User* must use reasonable endeavours to ensure that the *generating unit* responds in accordance with that agreement. Thermal *generating units* must be able to sustain *load*

changes of at least 10% for a *frequency* decrease and 20% for a *frequency* increase if changes occur within the above limits of output.

For Non-Dispatchable generating units

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

Non-dispatchable generating units with technologies which intrinsically allow the control of power output are required to be equipped with such controls to facilitate frequency control. For example, wind turbines with pitch control can control electric power output relative to the max energy that can be extracted from the wind.

Rate of Response

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

For Dispatchable generating units

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

For Non-Dispatchable generating units

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

3.2.5.4 Excitation Control System

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

- (a) limiting *generating unit* operation at all *load* levels to within *generating unit* capabilities for continuous operation;
- (b) controlling *generating unit* excitation to maintain the short-time average *generating unit* stator *voltage* at highest rated level (which must be at least 5% above the nominal stator *voltage* and is usually 10% above the nominal stator *voltage*);
- (c) maintaining adequate *generating unit* stability under all operating conditions including providing *power system* stabilising action if fitted with a *power system* stabiliser;

- (d) providing five second ceiling excitation *voltage* at least twice the excitation *voltage* required to achieve maximum continuous rating at nominal *voltage*; and
- (e) providing reactive current compensation settable for boost or droop unless otherwise agreed by *Western Power*.

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

All synchronous *generating units* with ratings in excess of 30 MW or smaller *generating units* within a *power station* totalling in excess of 30 MW, must incorporate *power system stabiliser (PSS)* circuits which modulate *generating unit field voltage* in response to changes in power output and/or shaft speed and/or any other equivalent input signal approved by *Western Power*. The stabilising circuits must be responsive and adjustable over a *frequency* range which must include frequencies from 0.1 Hz to 2.5 Hz. *Power system stabiliser* circuits may be required on synchronous *generating units* with ratings less than or equal to 30MW or smaller synchronous *generating units* within a *power station* totalling less than or equal to 30MW if *power system* simulations indicate such a requirement. Before commissioning of any *power system stabiliser*, its preliminary settings should be agreed by *Western Power*. The *User* should propose these preliminary settings which should be derived from system simulation studies and the study results reviewed by *Western Power*.

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

Table 3.1
Excitation System Performance Requirements

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

Notes:

1. One per unit is that field *voltage* required to produce nominal *voltage* on the airgap line of the generator open circuit characteristic (Refer IEEE Standard 115-1983 - Test Procedures for Synchronous Machines). Excitation control system with both proportional and integral actions should achieve a minimum equivalent gain of 200.
2. Rated field *voltage* is that *voltage* required to give nominal generator terminal *voltage* when the generator is operating at its maximum continuous rating. Rise time is defined as the time taken for the field *voltage* to rise from 10% to 90% of the increment value.
4. Settling time is defined as the time taken for the generator terminal *voltage* to settle and stay within an error band of $\pm 1\%$ of its increment value.
5. Voltage overshoot is defined as the largest deviation of the terminal voltage over the step increment value during the transient state.
6. Field voltage means generator field voltage.

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

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

Settings may require alteration from time to time as advised by *Western Power*. The cost of altering the settings and verifying subsequent performance must be borne by the *User*, provided alterations are not made more than once in each 18 months for each *generating unit*. If more frequent changes are requested the person making that request must pay all costs on that occasion. The preliminary settings backed up by any calculations and system studies to derive these settings must be made available to *Western Power* at least two months before the system tests stated in clause 4.1.3. Any new settings, if found necessary during the tests to improve performance should be provided by the *User*.

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

3.2.6 Power Station Auxiliary Transformers

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

3.2.7 Synchronising

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

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

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

3.2.8 Secure Electricity Supplies

Secure electricity supplies of adequate capacity to provide for the operation for at least eight

hours of *plant* performing *metering*, communication, monitoring, and *protection* functions, on the loss of AC supplies, must be provided by a *User*.

3.2.9 Design Requirements for *Users' Substations*

Users must comply with the requirements of clause 3.3.6.

3.2.10 Computer Model

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

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

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

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

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

3.2.11 Plant Performance during Start-up, Shut-down and Daily Operation

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

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

3.3 REQUIREMENTS FOR CONNECTION OF LOADS

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

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

- (1) not cause excessive load fluctuations, reactive power draw or, where applicable, stalling of motor loads that would adversely impact other *Users* or the TNSP.
- (2) not cause any reduction of inter-regional or intra regional power transfer capability based on:
 - (i) frequency stability, or
 - (ii) voltage stabilityby more than its loading level whenever connected relative to the level that would apply if the load *User* were disconnected.

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

3.3.1 Information

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

- (a) A single line diagram with the *protection* details.
- (b) *Metering system* design details for equipment being provided by the *User*.
- (c) A general arrangement locating all the equipment on the site.
- (d) A general arrangement for each new or altered *substation* showing all exits and the position of all electrical equipment.
- (e) Type test certificates for all new switchgear and *transformers*, including measurement *transformers* to be used for *metering* purposes in accordance with Section 6 (*metering*) of this *Code*.
- (f) The proposed methods of earthing cables and other equipment to comply with the relevant *Regulations*.
- (g) *Plant* and earth grid test certificates from approved test authorities.
- (h) A secondary injection of *protection* and trip test certificate on all circuit breakers.
- (i) Certification that all new equipment has been inspected before being *connected* to the *supply*.
- (j) Operational procedures.
- (k) Details of potentially disturbing *loads*.
- (l) *SCADA* arrangements.

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

3.3.2 Design Standards

A *User's* installation must comply with the relevant *Australian Standards* as applicable at the time, *good electricity industry practice* and this *Code*, including, but not limited to, the *power quality* standards as specified in clause 2.2.

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

Users will be responsible for ensuring that *plant* capabilities and ratings are reviewed on an ongoing basis to ensure continued suitability as conditions on the *power system* change in the future (e.g. increasing fault levels, or reduced critical fault clearing times, as additional *plant* is *connected* to the *power system*). A *User* will be responsible for the cost of any *plant* upgrades required at its *facilities* as a result of changing *power system* conditions.

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

3.3.3 User Protection Systems that Impact on Power System Security

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

3.3.4 Connection Point for a User

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

3.3.5 Power Factor Requirements

Power factor ranges to be met by *Users* for their *loads* are shown in the table 3.2 below:

Table 3.2
Power Factor Requirements (Loads)

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

Western Power may permit a lower lagging or leading *power factor* where this will not reduce *system security* and/or *quality of supply*, or require a higher lagging or leading *power factor* to achieve required *power transfers*.

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

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

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

3.3.6 Design Requirements for Users' Substations

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

- (a) Safety provisions must comply with requirements applicable and notified by *Western Power*;
- (b) Where required by *Western Power* appropriate interfaces and accommodation must be incorporated by the *User* for *metering*, communication *facilities*, remote monitoring and *protection* of *plant* which is to be installed in the *substation* by *Western Power*.
- (c) A *substation* must be capable of continuous uninterrupted operation with the levels of *voltage*, harmonics, unbalance and *voltage* fluctuation from all sources as defined in Section 2 of this *Code*.
- (d) Earthing of *primary plant* in the *substation* must be in accordance with the Electricity Supply Association of Australia Safe Earthing Guide, AS3000 and the Western Australian Electrical Requirements. A users earthing system must satisfy the requirements of these publications without any reliance on *Western Power* facilities.
- (e) *Synchronisation facilities* or reclose blocking must be provided if *generating units* are connected through the *substation*.
- (f) Secure electricity supplies of adequate capacity to provide for the operation for at least eight hours of *plant* performing *metering*, communication, monitoring, and *protection* functions, on loss of AC supplies, must be provided.
- (g) *Plant* must be tested to ensure that the *substation* complies with the design and

specifications which have been certified as required by clause 3.3.6(j).

- (h) The *protection* equipment required would normally include *protection schemes* for individual items of *plant*, back-up arrangements, auxiliary d.c. supplies and instrumentation *transformers*.
- (i) Insulation levels of *plant* in the *substation* must co-ordinate with the insulation levels of the *network* to which the *substation* is *connected* without degrading the design performance of the *network*.
- (j) Prior to *connection* to the *Western Power power system*, the *User* shall have provided to *Western Power* a signed written statement to certify that the equipment to be *connected* has been designed and installed in accordance with this *Code*, all relevant standards, all statutory requirements and *good electricity industry practice*. The statement shall have been certified by a Chartered Professional Engineer with NPER-3 standing with the Institution of Engineers, Australia, unless otherwise agreed.

3.3.7 Load Shedding Facilities

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

3.3.8 Monitoring and Control Requirements

3.3.8.1 Remote Monitoring

Western Power will require the User to:

- I. provide *remote monitoring equipment* ("*RME*") to enable *Western Power* to remotely monitor status and indications of the *load facilities* where this is reasonably necessary in real time for control, planning or security of the *power system*; and
- II. upgrade, modify or replace any *RME* already installed in a *user's substation* provided that the existing *RME* is, in the reasonable opinion of *Western Power*, no longer fit for purpose and notice is given in writing to the relevant *User*.

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

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

- (a) Status Indications
 - (1) relevant circuit breakers open/closed (double pole) within the *plant*
 - (2) relevant isolators within the *plant*
 - (3) *connection* to the *transmission network*
 - (4) relevant earth switches

- (b) Alarms
 - (1) *protection* operation

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

(c) Measured Values

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

(d) Power Quality Monitoring Equipment.

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

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

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

3.3.8.2 Communications Equipment

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

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

3.3.9 Secure Electricity Supplies

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

3.4 PROTECTION REQUIREMENTS

The requirements of this clause 3.4 apply only to a *Users' protection* which is necessary to maintain *power system security*. *Protection* installed solely to cover risks associated with a *User's plant* and equipment is at the *User's* discretion. The extent of a *User's plant* and equipment which will need to conform with the requirements of this clause 3.4 will vary from installation to installation. Consequently, each installation will need to be assessed individually by *Western Power*. *Users* will be advised accordingly.

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

3.4.1 Obligation to Provide Adequate Protection

3.4.1.1 Safety of People

It is the *User's* responsibility to provide adequate *protection* (at the *User's* discretion) of all *User* owned *plant* to ensure the safety of the public and personnel, and to minimise damage.

3.4.1.2 System Reliability and Integrity

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

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

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

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

3.4.2 Overall Protection Requirements

3.4.2.1 Minimum Standard of Protection Equipment

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

3.4.2.2 Availability of Protection

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

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

3.4.2.3 Duplication of Protection

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

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

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

3.4.2.4 Protection Performance where Critical Fault Clearance Time Exists

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

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

3.4.2.5 Maximum Acceptable Total Fault Clearance Time

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

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

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

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

		Existing Equipment No CB Fail	Existing Equipment CB Fail	New Equipment No CB Fail	New Equipme nt CB Fail
220kV and above	Local	120	370	100	250
	Remote	180	420	140	290
66kV and 132kV	Local	150	400	105	270
	Remote	200	450	160	325

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

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

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

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

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

		Existing Equipment No CB Fail	Existing Equipment CB Fail	New Equipment No CB Fail	New Equipme nt CB Fail
132kV	Local	150	400	120	270
	Remote	400	650	400	565
66kV	Local	1000	>1000	105	270
	Remote	>1000	>1000	400	565

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

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

3.4.2.6 Sensitivity of Protection

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

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

3.4.2.7 Clearance of Small Zone Faults

Small zone faults shall be detected and cleared by *backup protection* as specified in clause 3.4.3.7. The clearance time requirements for small zone faults are the same as those specified in Clause 3.4.2.5 for Circuit Breaker Fail conditions. The reliance on remote backup protection shall be reduced by ensuring that circuit breaker fail protection initiates the circuit breaker fail protection of the circuit breakers that they are tripping.

3.4.2.8 Clearance of Faults under Circuit Breaker Fail Conditions

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

3.4.2.9 Protection of Interconnections and Ties

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

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

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

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

3.4.2.10 DC Functions of *Protection Apparatus*

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

3.4.2.11 *Protection Flagging and Indication*

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

3.4.2.12 *Trip Supply Supervision Requirements*

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

3.4.2.13 *Trip Circuit Supervision Requirements*

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

3.4.2.14 *Details of Proposed User Protection*

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

3.4.2.15 *Details of Proposed User Protection Settings*

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

3.4.2.16 Coordination of *Protection* Settings

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

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

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

3.4.2.17 Commissioning of *Protection*

Western Power reserves the right to witness the commissioning tests on any of the *User's protection* that it deems to be important or critical for the reliable operation and integrity of the *Western Power power system*. The *user* shall pay *Western Power's* reasonable costs associated with the witnessing of the commissioning tests.

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

3.4.2.18 Maintenance of *Protection*

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

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

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

3.4.3 Specific *Protection* Requirements

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

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

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

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

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

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

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

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

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

3.4.3.3 Transformers

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

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

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

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

3.4.3.4 Generators

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

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

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

3.4.3.5 Check Synchronising

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

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

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

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

3.4.3.6 Protection Alarm Requirements

Specific requirements and the interface point to which alarms shall be provided will be mutually decided during the detailed design phase. These alarms will be brought back to the *Western Power control centre* via the installed *SCADA system* supplied by the *User* in accordance with clause 3.2.5.1 or clause 3.3.8.1, as applicable.

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

3.4.3.7 Backup Protection

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

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

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

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

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

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

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

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

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

3.4.3.9 Automatic Reclose Equipment

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

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

4.1 INSPECTION AND TESTING

4.1.1 Right of Entry and Inspection

- a) *Western Power* or any of its *representatives* (including authorised agents) may, in accordance with clause 4.1, inspect a *facility* of a *User* and the operation and maintenance of that *facility* in order to:
- 1) assess compliance by the relevant *User* with its operational obligations under the *Regulations*, or the *Code*, or an *access agreement*, or an *ancillary services agreement*; or
 - 2) investigate any possible past or potential threat to *power system security*; or
 - 3) conduct any periodic familiarisation or training associated with the operational requirements of the *facility*.
- b) If *Western Power* wishes to inspect the *facilities* of a *User* under clause 4.1.1(a), *Western Power* must give that *User* at least 2 *business days*’ notice in writing of its intention to carry out an inspection. In the case of an emergency condition affecting the *power system* which *Western Power* reasonably considers requires access to the *User’s facility*, prior notice is not required, however, *Western Power* shall notify the *User* as soon as practicable after deciding to enter the *User’s facility* of the nature and extent of *Western Power’s* activities at the *User’s facility*.
- c) A notice given under clause 4.1.1(b) must include the following information:
- 1) the name of the *representative* who will be conducting the inspection on behalf of *Western Power*;
 - 2) subject to clause 4.1.1(h), the time when the inspection will commence and the expected time when the inspection will conclude; and
 - 3) if associated with clause 4.1.1(a)(1) then the nature of the suspected non-compliance with the *Code* or *access agreement* or *ancillary services agreement*, or if associated with clauses 4.1.1(a)(2) or 4.1.1(a)(3) then the relevant reasons for the inspection.
- d) *Western Power* may not carry out an inspection under clause 4.1 within 6 months of any previous inspection except for the purpose of verifying the performance of corrective action claimed to have been carried out in respect of a non-conformance observed and documented on the previous inspection or for the purpose of investigating an operating incident in accordance with clause 5.8.11.
- e) At any time when the *representative* of *Western Power* is in a *User’s facility*, that *representative* must:
- 1) cause no damage to the *facility*;

- 2) only interfere with the operation of the *facility* to the extent reasonably necessary and approved by the relevant *User* (such approval not to be unreasonably withheld or delayed);
 - 3) observe "permit to test" access to sites and clearance protocols of the operator of the *facility*, provided that these are not used by the *facility* solely to delay the granting of access to site and inspection;
 - 4) observe the requirements of the operator of the *facility* in relation to occupational health and safety and industrial relations matters, which requirements are of general application to all invitees entering on or into the *facility*, provided that these are not used by the *facility* solely to delay the granting of access to site and inspection; and
 - 5) not ask any question other than as reasonably necessary for the purpose of such inspection or give any *direction*, instruction or advice to any person involved in the operation or maintenance of the *facility* other than the operator of the *facility* or unless approved by the operator of the *facility*.
- f) Any *representative* of *Western Power* conducting an inspection under this clause 4.1.1 must be appropriately qualified and experienced to perform the relevant inspection. If so requested by the *User*, *Western Power* shall procure that a *representative* of *Western Power* (other than an employee) gaining access under this *Code* or an *access agreement* enters into a confidentiality undertaking in favour of the *User* in a form reasonably acceptable to the *User* prior to gaining such access.
- g) The costs of inspections under this clause 4.1.1 must be borne by the *User* if the suspected non-compliance is later proved by tests.
- h) Any inspection under clause 4.1.1(a) must not take longer than one *day* unless *Western Power* seeks approval from the *User* for an extension of time (such approval not to be unreasonably withheld or delayed).
- i) Any equipment or goods installed or left on land or in premises of a *User* after an inspection conducted under clause 4.1.1 do not become the property of the relevant *User* (notwithstanding that they may be annexed or affixed to the relevant land or premises).
- j) In respect of any equipment or goods left on land or premises of a *User* during or after an inspection, a *User*:
- 1) must not use any such equipment or goods for a purpose other than as contemplated in this *Code* without the prior written approval of the owner of the equipment or goods;
 - 2) must allow the owner of any such equipment or goods to remove any such equipment or goods in whole or in part at a time agreed with the relevant *User* with such agreement not to be unreasonably withheld or delayed;
 - 3) must not create or cause to be created any mortgage, charge or lien over any such equipment or goods; and
 - 4) must reimburse the owner of any such equipment or goods for reasonable costs and expenses suffered or incurred by the owner due to loss or damage to any such equipment or goods caused by the *User*.

4.1.2 Right of Inspection and Testing

- (a) If *Western Power* has reasonable grounds to believe that equipment owned or operated by a *User* may not comply with the *Regulations*, *Code* or the *access agreement*, *Western Power* may require testing of the relevant equipment by giving notice in writing to the *User*.
- (b) If a notice is given under clause 4.1.2(a) the relevant test is to be conducted at a time agreed by *Western Power*.
- (c) The *User* who receives a notice under clause 4.1.2(a) must co-operate in relation to conducting tests requested under clause 4.1.2(a).
- (d) The cost of tests requested under clause 4.1.2(a) must be borne by *Western Power*, unless the equipment is determined by the tests not to comply with the relevant *access agreement*, *Code* and/or the *Regulations*, in which case all reasonable costs of such tests must be borne by the owner of that equipment.
- (e) Tests conducted in respect of a *connection point* under clause 4.1.2 must be conducted using test procedures agreed between the relevant *Users*, which agreement is not to be unreasonably withheld or delayed.
- (f) Tests under clause 4.1.2 must be conducted only by persons with the relevant skills and experience.
- (g) If *Western Power* requests a test under this clause 4.1.2, *Western Power* may appoint a *representative* to witness a test and the relevant *User* must permit a *representative* appointed under this clause 4.1.2(g) to be present while the test is being conducted.
- (h) Subject to clause 4.1.2(i), a *User* who conducts a test must submit a report to *Western Power* within a reasonable period after the completion of the test and the report is to outline relevant details of the tests conducted, including but not limited to the results of those tests.
- (i) If a performance test or monitoring of in-service performance demonstrates that equipment owned or operated by a *User* does not comply with the *Regulations*, this *Code* or the relevant *access agreement* then the *User* must:
 - (1) promptly notify *Western Power* of that fact; and
 - (2) promptly advise *Western Power* of the remedial steps it proposes to take and the timetable for such remedial work; and
 - (3) diligently undertake such remedial work and report at monthly intervals to *Western Power* on progress in implementing the remedial action; and
 - (4) conduct further tests or monitoring on completion of the remedial work to confirm compliance with the relevant technical requirement.
- (j) *Western Power* may attach test equipment or *monitoring equipment* to *plant* owned by

a *User* or require a *User* to attach such test equipment or *monitoring equipment*, subject to the provisions of clause 4.1.1 regarding entry and inspection.

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

4.1.3 Tests to Demonstrate Compliance with Connection Requirements for Generators

- (a) Each *User* must provide evidence to *Western Power* that each of its generating units complies with the technical requirements of Clause 3.2 and the relevant access agreement. In addition, each *User* must provide facilities to carry out power system tests prior to commercial operation in order to verify acceptable performance of each generating unit, and provide information and data necessary for computer model validation. These test requirements, primarily for synchronous generators are detailed in Table A10.1 of Attachment 10. *Western Power* will specify test requirements for other forms of non-synchronous generatio, solar panel and fuel cell, which may also involve AC/DC/AC power conversion.

Other special tests may be specified by *Western Power*, and *Users* will be advised accordingly. Examples of some of these special tests are listed in Table A10.2 of Attachment 10. Where testing is not practical, *Western Power* may request a *User* to install recording equipment at appropriate locations in order to confirm compliance of performance.

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

The *User* shall forward test procedures which incorporate test requirements in Attachment 10 and details of the recorders and measurement equipment to be used in the tests to *Western Power* for approval 30 business days before the tests. The *User* is responsible for providing all necessary recorders and other measurement equipment for the tests.

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

All test results and associated relevant information including final transfer function block diagrams and settings of AVR, PSS, UEL and OEL shall be forwarded to *Western Power* within 5 business days after the test.

- (b) Each *User* must negotiate in good faith with *Western Power* to agree on a compliance monitoring program, including an agreed method, for each of its *generating units* to confirm ongoing compliance with the applicable technical requirements of Clause 3.2 and the relevant *access agreement*.
- (c) If a performance test or monitoring of in-service performance demonstrates that a *generating unit* is not complying with one or more technical requirements of Clause 3.2 and the relevant *access agreement* then the *User* must:
- (1) promptly notify *Western Power* of that fact; and
 - (2) promptly advise *Western Power* of the remedial steps it proposes to take and the timetable for such remedial work; and
 - (3) diligently undertake such remedial work and report at monthly intervals to *Western Power* on progress in implementing the remedial action; and
 - (4) conduct further tests or monitoring on completion of the remedial work to confirm compliance with the relevant technical requirement.
- (d) If *Western Power* reasonably believes that a *generating unit* is not complying with one or more technical requirements of Clause 3.2 and the relevant *access agreement*, *Western Power* may instruct the *User* to conduct tests within 25 *business days* to demonstrate that the relevant *generating unit* complies with those technical requirements and if the tests provide evidence that the relevant *generating unit* continues to comply with the technical requirement(s) *Western Power* must reimburse the *User* for the reasonable expenses incurred as a direct result of conducting the tests.
- (e) If *Western Power*:
- (1) is satisfied that a *generating unit* does not comply with one or more technical requirements; and
 - (2) does not have evidence demonstrating that a *generating unit* complies with the technical requirements set out in Clause 3.2; or
 - (3) holds the reasonable opinion that there is or could be a threat to the *power system security*,
- Western Power* may direct the relevant *User* to operate the relevant *generating unit* at a particular *generated* output or in a particular mode until the relevant *User* submits evidence reasonably satisfactory to *Western Power* that the *generating unit* is complying with the relevant technical requirement.
- (f) A *direction* under clause 4.1.3(e) must be recorded by *Western Power*.
- (g) From the *Code commencement date* or from the date of access, whichever is the later, each *User* must maintain records and retain them for a minimum of 7 years (from the date of creation of each record) for each of its *generating units* and *power stations* setting out details of the results of all technical performance and monitoring conducted under this clause 4.1.3 and make these records available to *Western Power* on request.

4.1.4 Routine Testing of *Protection* Equipment

- a) Subject to clause 3.4.2.18, a *User* must cooperate with *Western Power* to test the operation of equipment forming part of a *protection scheme* relating to a *connection point* at which that *User* is *connected* to a *network* and the *User* must conduct these tests :
- 1) prior to the *plant* at the relevant *connection point* being placed in service; and
 - 2) at intervals specified in the *access agreement* or in accordance with an asset management plan agreed between *Western Power* and the *User*.
- b) A *User* shall, on request from *Western Power*, demonstrate to *Western Power's* satisfaction the correct calibration and operation of the *User's* protective devices.
- c) Each *User* shall pay *Western Power's* reasonable costs and shall bear its own costs of conducting tests under this clause 4.1.4.

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

- (a) A *User* proposing to conduct a test on equipment related to a *connection point*, which requires a change to the operation of that equipment as specified in the *access agreement*, must give notice in writing to *Western Power* of at least 15 *business days* except in an emergency.
- (b) The notice to be provided under clause 4.1.5(a) is to include:
- (1) the nature of the proposed test;
 - (2) the estimated start and finish time for the proposed test;
 - (3) the identity of the equipment to be tested;
 - (4) the *power system* conditions required for the conduct of the proposed test;
 - (5) details of any potential adverse consequences of the proposed test on the equipment to be tested;
 - (6) details of any potential adverse consequences of the proposed test on the *power system*; and
 - (7) the name of the person responsible for the coordination of the proposed test on behalf of the *User*.
- (c) *Western Power* must review the proposed test to determine whether the test:
- (1) could adversely affect the normal operation of the *power system* ;
 - (2) could cause a threat to *power system security*;
 - (3) requires the *power system* to be operated in a particular way which differs from the way in which the *power system* is normally operated; or
 - (4) could affect the normal *metering* of *energy* at a *connection point*;
- (d) If, in *Western Power's* reasonable opinion, a test could threaten public safety, damage or threaten to damage equipment or adversely affect the operation of the *power system*, *Western Power* may direct that the proposed test procedure be modified or that the test not be conducted at the time proposed.

- (e) *Western Power* must advise any other *Users* who will be adversely affected by a proposed test and consider any reasonable requirements of those *Users* when approving the proposed test.
- (f) The *User* who conducts a test under this clause 4.1.5 must ensure that the person responsible for the coordination of a test promptly advises *Western Power* when the test is complete.
- (g) If *Western Power* approves a proposed test, *Western Power* must use its reasonable endeavours to ensure that *power system* conditions reasonably required for that test are provided as close as is reasonably practicable to the proposed start time of the test and continue for the proposed duration of the test.
- (h) Within a reasonable period after any such test has been conducted, the *User* who has conducted a test under this clause 4.1.5 must provide *Western Power* with a report in relation to that test including test results where appropriate.

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

- (a) *Western Power* may, at intervals of not less than 12 months per *generating unit*, require the testing by a *User* of any *generating unit connected* to the *network* of *Western Power* in order to determine analytic parameters for modelling purposes or to assess the performance of the relevant *generating unit* and *Western Power* is entitled to witness such tests. *Western Power* must have reasonable grounds for requiring such tests.
- (b) Adequate notice of not less than 15 *business days* must be given by *Western Power* to the *User* before the proposed date of a test under clause 4.1.6(a).
- (c) *Western Power* must use its reasonable endeavours to ensure that tests permitted under this clause 4.1.6 are to be conducted at a time which will minimise the departure from the *commitment* that is due to take place at that time .
- (d) If not possible beforehand, a *User* must conduct a test under clause 4.1.6 at the next scheduled *outage* of the relevant *generating unit* and in any event within 9 months of the request.
- (e) A *User* must provide any reasonable assistance requested by *Western Power* in relation to the conduct of tests.
- (f) Tests conducted under clause 4.1.6 must be conducted in accordance with test procedures agreed between *Western Power* and the relevant *User* and a *User* must not unreasonably withhold its agreement to test procedures proposed for this purpose by *Western Power*.
- (g) *Western Power* must provide to a *User* such details of the analytic parameters of the model derived from the tests referred to in clause 4.1.6 for any of that *User's generating units* as may reasonably be requested by the *User*.

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

4.1.7 Power System Tests

- (a) Tests conducted for the purpose of either verifying the magnitude of the *power transfer capability of transmission networks* or investigating *power system* performance must be coordinated and approved by *Western Power*. *Western Power* or a *User* requesting such tests must have reasonable grounds for requiring such tests.
- (b) The tests described in clause 4.1.7(a) may be conducted whenever:
- (1) a new *generating unit* or *facility* of a *Customer*, *User* or a *network* development is commissioned that is calculated or anticipated to substantially alter *power transfer capability* through the *transmission network*;
 - (2) setting changes are made to any turbine control *system* and *excitation control system*, including *power system* stabilisers; or
 - (3) a test is required to verify the performance of the *power system* or to validate computer models.
- (c) *Western Power* must notify all *Users* which could reasonably be expected to be affected by the proposed test at least 15 *business days* before any test under this clause 4.1.7 may proceed and consider any reasonable requirements of those *Users* when approving the proposed test.
- (d) Operational conditions for each test must be arranged by *Western Power* and the test procedures must be coordinated by an officer nominated by *Western Power* who has authority to stop the test or any part of it or vary the procedure within pre-approved guidelines if it considers any of these actions to be reasonably necessary.
- (e) Each *User* must cooperate with *Western Power* when required in planning, preparing for and conducting *transmission network tests* to assess the technical performance of the *transmission networks* and if necessary conduct co-ordinated activities to prepare for *power system* wide testing or individual, on-site tests of the *User's facilities* or *plant*, including *disconnection* of a *generating unit*.
- (f) *Western Power* may direct operation of *generating units* by *Users* during *power system tests* if this is necessary to achieve operational conditions on the *transmission networks* which are reasonably required to achieve valid test results.
- (g) *Western Power* must plan the timing of tests so that the variation from *dispatch* that would otherwise occur is minimised and the duration of the tests is as short as possible consistent with test requirements and *power system security*.
- (h) Each *User* is to bear its own costs of conducting tests under this clause 4.1.7 and no compensation is to be payable for financial losses incurred as a result of these tests or associated activities.

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

4.2 COMMISSIONING

4.2.1 Requirement to Inspect and Test Equipment

- (a) A *User* must ensure that any of its new or replacement equipment is inspected and tested to demonstrate that it complies with relevant *Australian Standards*, relevant international standards, this *Code*, the *Regulations* and any relevant *access agreement* prior to or within an agreed time after being *connected* to a *transmission network*, and *Western Power* is entitled to witness such inspections and tests.
- (b) The *User* must produce test certificates on request by *Western Power* showing that the equipment has passed the tests and complies with the standards set out in clause 4.2.1(a) before *connection* to the *power system*, or within an agreed time thereafter.

4.2.2 Co-Ordination during Commissioning

A *User* seeking to *connect* to a *network* must cooperate with *Western Power* to develop procedures to ensure that the commissioning of the *connection* and *connected* facility is carried out in a manner that:

- 1) does not adversely affect other *Users* or affect *power system security* or *quality of supply* of the *power system*; and
- 2) minimises the threat of damage to any other *User's* equipment.

4.2.3 Control and Protection Settings for Equipment

- (a) Not less than 65 *business days* prior to the proposed commencement of commissioning of any new or replacement equipment that could reasonably be expected to alter performance of the *power system*, the *User* must submit to *Western Power* sufficient design information including proposed parameter settings to allow critical assessment including analytical modelling of the effect of the new or replacement equipment on the performance of the *power system*.
- (b) *Western Power* must:
 - (1) consult with other *Users* as appropriate; and
 - (2) within 20 *business days* of receipt of the design information under clause 4.2.3(a), notify the *User* of any comments on the proposed parameter settings for the new or replacement equipment.
- (c) If *Western Power's* comments include alternative parameter settings for the new or replacement equipment, then the *User* must notify *Western Power* within 10 *business days* that it either accepts or disagrees with the alternative parameter settings

suggested by *Western Power*.

- (d) *Western Power* and the *User* must negotiate parameter settings that are acceptable to them both and if there is any unresolved disagreement between them, the matter must be referred to the *Referee*.
- (e) The *User* and *Western Power* must co-operate with each other to ensure that adequate grading of *protection* is achieved so that faults within the *User's* facility are cleared without adverse effects on the *power system*.
- (f) The *User* must pay *Western Power's* reasonable costs associated with the assessment of the parameter settings under this clause 4.2.3.

4.2.4 Commissioning Program

- (a) Not less than 65 *business days* prior to the proposed commencement of commissioning by a *User* of any new or replacement equipment that could reasonably be expected to alter performance of the *power system*, the *User* must advise *Western Power* in writing of the commissioning program including test procedures and proposed test equipment to be used in the commissioning.
- (b) *Western Power* must, within 20 *business days* of receipt of such advice under clause 4.2.4(a), notify the *User* either that it:
 - (1) agrees with the proposed commissioning program and test procedures; or
 - (2) requires changes in the interest of maintaining *power system security*, safety or *quality of supply*.
- (c) If *Western Power* requires changes, then the parties must co-operate to reach agreement and finalise the commissioning program within a reasonable period.
- (d) A *User* must not commence the commissioning until the commissioning program has been finalised and *Western Power* must not unreasonably delay finalising a commissioning program.
- (e) The *User* must pay *Western Power's* reasonable costs associated with the assessment of the commissioning program under this clause 4.2.4.

4.2.5 Commissioning Tests

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

Prior to *connection* to the *Western Power power system*, the *User* shall have provided to *Western Power* a signed written statement to certify that the equipment to be *connected* has been installed in accordance with the *Regulations*, this *Code*, the relevant *access agreement*, all relevant standards, all statutory requirements and *good electricity industry practice*. The statement shall have been certified by a Chartered Professional Engineer

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

- (b) *Western Power* must, within a reasonable period of receiving advice of commissioning tests, notify the *User* whose new or replacement equipment is to be tested under this clause 4.2.5 whether or not it:
 - (1) wishes to witness the commissioning tests; and
 - (2) agrees with the proposed commissioning times.
- (c) A *User* whose new or replacement equipment is tested under this clause 4.2.5 must submit to *Western Power* the commissioning test results demonstrating that a new or replacement item of equipment complies with this *Code* or the relevant *access agreement* or both to the satisfaction of *Western Power*.
- (d) If the commissioning tests conducted in relation to a new or replacement item of equipment demonstrates non-compliance with one or more requirements of this *Code* or the relevant *access agreement* then the *User* whose new or replacement equipment was tested under this clause 4.2.5 must promptly meet with *Western Power* to agree on a process aimed at achievement of compliance of the relevant item with this *Code*.
- (e) *Western Power* may direct that the commissioning and subsequent *connection* of the *User's* equipment should not proceed if the relevant equipment does not meet the technical requirements specified in clause 4.2.1.
- (f) All commissioning and testing of *User* owned equipment shall be carried out by personnel experienced in the commissioning of *power system primary plant* and *secondary plant*.
- (g) The *User* must pay *Western Power's* reasonable costs associated with the witnessing of commissioning tests under this clause 4.2.5.

4.3 DISCONNECTION AND RECONNECTION

4.3.1 Voluntary Disconnection

- (a) Unless agreed otherwise and specified in an *access agreement*, a *User* must give to *Western Power* notice in writing of its intention to permanently *disconnect* a *facility* from a *connection point*.
- (b) A *User* is entitled, subject to the terms of the relevant *access agreement*, to require voluntary permanent *disconnection* of its equipment from the *power system* in which case appropriate operating procedures necessary to ensure that the *disconnection* will not threaten *power system security* must be implemented in accordance with clause 4.3.2.
- (c) The *User* must pay all costs directly attributable to the voluntary *disconnection* and *decommissioning*.

4.3.2 Decommissioning Procedures

- (a) In the event that a *User's* facility is to be permanently *disconnected* from the *power system*, whether in accordance with clause 4.3.1 or otherwise, *Western Power* and the *User* must, prior to such *disconnection* occurring, follow agreed procedures for *disconnection*.
- (b) *Western Power* must notify other *Users* if it believes, in its reasonable opinion, the terms and conditions of such a *access agreement* will be affected by procedures for *disconnection* or proposed procedures agreed with any other *User*. The parties must negotiate any amendments to the procedures for *disconnection* or the *access agreement* that may be required.
- (c) Any *disconnection* procedures agreed to or determined under clause 4.3.2(a) must be followed by *Western Power* and all *Users*.

4.3.3 Involuntary Disconnection (refer also to clause 5.8)

- a) *Western Power* may *disconnect* a *User's* facilities from a *network* :
 - 1) during an emergency in accordance with clause 4.3.5;
 - 2) in accordance with relevant laws; or
 - 3) in accordance with the provisions of the *User's* *access agreement*.
- b) In all cases of *disconnection* by *Western Power* during an emergency in accordance with clause 4.3.5, *Western Power* is required to undertake a review under clause 5.8.11 and *Western Power* must then provide a report to the *User* advising of the circumstances requiring such action.

4.3.4 Disconnection Due to Breach of an Access Agreement

- a) Subject to the relevant provisions of the *Regulations*, *Western Power* may *disconnect* a *User's* facilities from a *transmission network* if in *Western Power's* reasonable opinion, the *User* has breached a term of the *access agreement* and such breach poses a threat to *power system security*. In such circumstances *Western Power* will not be liable in any way for any loss or damage suffered or incurred by the *User* by reason of the *disconnection* and *Western Power* will not be obliged for the duration of the *disconnection* to fulfil any agreement to convey electricity to or from the *User's* facility.
- b) A *User* must not bring proceedings against *Western Power* to seek to recover any amount for any loss or damage described in clause 4.3.4(a).
- c) Transmission charges must be paid by a *User* whose facilities have been *disconnected* under this clause 4.3.4 as if any *disconnection* had not occurred.

4.3.5 Disconnection During an Emergency

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

- a) request the relevant *User* to reduce the *power transfer* at the proposed point of *disconnection* to zero in an orderly manner and then *disconnect* the *User's* facility by automatic or manual means; or
- b) immediately *disconnect* the *User's facilities* by automatic or manual means where, in *Western Power's* reasonable opinion, it is not appropriate to follow the procedure set out in clause 4.3.5(a) because action is urgently required as a result of a threat to safety of persons, hazard to equipment or a threat to *power system security*.

4.3.6 Obligation to Reconnect

Western Power must reconnect a *User's facilities* to a *transmission network* at a reasonable cost to the *User* as soon as practicable if:

- (a) a breach of the *Regulations, Code* or *access agreement* giving rise to *disconnection* has been remedied; or
- (b) where the breach is not capable of remedy, compensation has been agreed and paid by the *User* to the affected parties or, failing agreement, the amount of compensation payable has been determined in accordance with the Dispute Resolution and *Electricity Referee Regulations* and that amount has been paid; or
- (c) where the breach is not capable of remedy and the amount of compensation has not been agreed or determined, assurances for the payment of reasonable compensation have been given to the satisfaction of *Western Power* and the parties affected; or
- (d) the *User* has taken all necessary steps to prevent the re-occurrence of the breach and has delivered binding undertakings to *Western Power* that the breach will not re-occur.

5. POWER SYSTEM SECURITY

5.1 INTRODUCTION

5.1.1 Purpose and Application of Section 5

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

5.2 POWER SYSTEM SECURITY PRINCIPLES

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

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

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

5.2.1 Satisfactory Operating State

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

- (a) the *frequency* at all energised *busbars* of the *power system* is in accordance with the frequency operating standards as specified in Table 2.1;
- (b) the *voltage* magnitudes at all energised *busbars* of the *transmission network* are within the relevant limits set by *Western Power* in accordance with this *Code* and clause 2.2.2 of this *Code*;
- (c) the current flows on all *transmission lines* of the *transmission network* are within the ratings (accounting for time dependency in the case of emergency ratings) as defined by *Western Power*;
- (d) all other *plant* forming part of or impacting on the *power system* is being operated within the relevant operating ratings (accounting for time dependency in the case of emergency ratings) as defined by *Western Power*;

- (e) the configuration of the *transmission network* is such that the severity of any potential fault is within the capability of transmission circuit breakers to *disconnect* the faulted circuit or equipment; and
- (f) the conditions of the *power system* are stable in accordance with requirements designated in or under clause 2.3.

5.2.2 Secure Operating State

- (a) The *power system* is defined to be in a *secure operating state* if, in *Western Power's* reasonable opinion, taking into consideration the appropriate *power system security* principles described in clause 5.2.4:
 - (1) the *power system* is in a *satisfactory operating state*; and
 - (2) The *power system* can be promptly returned to a *satisfactory operating state* following the occurrence of *credible contingency events* (events considered in accordance with clause 2.5 of this *Code*) with the *frequency and voltage* remaining within the limits specified in clauses 5.2.1(a) and 5.2.1(b), respectively.
- (b) Without limitation, in forming the opinions described in clause 5.2.2(a), *Western Power* must:
 - (1) consider the impact of each of the potentially *constrained interconnectors*; and
 - (2) use the *technical envelope* as the basis of determining events considered to be *credible contingency events* at that time.
- (c) A part of the *power system* is considered to be in a *secure operating state*, even though *Western Power* considers the provisions of clause 5.2.2(a)(2) to be not satisfied, where:
 - (1) The design of that part of *power system* does not meet this level of security; and
 - (2) the *Users* connected to that part of the *transmission network* have accepted such lower level of security. A *User* is considered to have accepted such lower level of security in relation to a part of the *power system* so designed unless the *connection agreement* between that *User* and *Western Power* provides otherwise; and
 - (3) *Users* have provided automatic and/or manually *interruptible load* in accordance with their *access agreement* and this *Code*.

5.2.3 Technical Envelope

- (a) The *technical envelope* means the technical boundary limits of the *power system* for achieving and maintaining the *secure operating state* of the *power system* for a given demand and *power system* scenario.
- (b) *Western Power* must determine and revise the *technical envelope* (as may be necessary from time to time) by taking into account the prevailing *power system* and *plant* conditions as described in clause 5.2.3(c).
- (c) The *technical envelope* determination must take into account matters including but not limited to:

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

- (2) the provision of the applicable *contingency capacity reserves*;
- (3) operation within all *plant* capabilities and *constraints* on the *power system*;
- (4) *contingency capacity reserves* available to handle *credible contingency events* in accordance with clause 2.5 of this *Code*;
- (5) agreed *generation load constraints*;
- (6) *constraints* on the *transmission network*, including short term limitations;
- (7) *frequency* control requirements;
- (8) *reactive power* support and *ancillary services* requirements; and
- (9) the existence of proposals for any major equipment or *plant* testing, including the checking or possible changes in *transmission plant* availability.

5.2.4 General Principles for Maintaining Power System Security

The *power system security* principles are as follows:

- (a) To the extent practicable, the *power system* should be operated such that it is and will remain in a *secure operating state*.
- (b) Following a *credible contingency event* or a significant *change* in *power system* conditions, it is possible that the *power system* may no longer be in a condition which could be considered secure on the occurrence of a further *contingency event*. In that case, *Western Power* should take all reasonable actions to adjust, wherever possible, the operating conditions with a view to returning the *power system* to its *satisfactory operating state* as soon as practical.
- (c) Adequate *load shedding facilities* initiated automatically by *frequency* or *voltage* conditions outside the *normal operating frequency or voltage excursion band* should be available and in service to restore the *power system* to a *satisfactory operating state* following significant *contingency events*.
- (d) *Users* shall be required, either under their *access agreements* or *ancillary services agreements*, to provide and maintain all required *facilities* consistent with both their *access agreement* and *good electricity industry practice* and operate their equipment in a manner:
 - (1) to assist in preventing or controlling instability within the *power system*;
 - (2) to assist in the maintenance of, or restoration to a *satisfactory operating state* of the *power system*;
 - (3) to prevent uncontrolled separation of the *transmission network* into isolated *regions* or partly combined *regions*, *intra-regional transmission* break-up, or *cascading outages*, following any *power system* incident; and
 - (4) in accordance with the technical requirements of their *access agreement*
- (e) *Users* shall arrange sufficient *black start-up* provisions so as to allow the restoration and any necessary restarting of their *generating units* following a *black system* condition.

5.2.5 Time for Undertaking Action

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

5.3 POWER SYSTEM SECURITY RESPONSIBILITIES AND OBLIGATIONS

5.3.1 Responsibility of Western Power for Power System Security

The *Western Power* power system security responsibilities are:

- (a) to maintain *power system security*;
- (b) to take reasonable steps to ensure that *high voltage* switching procedures and arrangements are utilised by *Users* to provide adequate *protection* of the *power system*;
- (c) to assess potential infringement of the *technical envelope* or *power system operating procedures* which could affect the security of the *power system*;
- (d) to operate the *power system* within the limits of the *technical envelope*;
- (e) to operate all *plant* and equipment under its control or co-ordination within the appropriate operational or emergency limits which are either established by *Western Power* or advised by the respective *Users*;
- (f) to assess the impacts of any technical and operational *constraints* on the operation of the *power system*;
- (g) to monitor the *dispatch* of *generating units* and *associated loads* to ensure they stay within both their allowable limits and the dynamic limits of the *technical envelope*;
- (h) to determine any potential *constraint* on the *operation* of *generating units* and *loads* and to assess the effect of this *constraint* on the maintenance of *power system security*;
- (i) to assess the availability and adequacy, including the dynamic response, of *contingency capacity reserves* and *reactive power reserves* in accordance with Section 2 of this *Code* and to take reasonable steps to ensure that appropriate levels of *contingency capacity reserves* and *reactive power reserves* are available:
 - (1) to ensure the *power system* is, and is maintained, in a *satisfactory operating state*; and
 - (2) to arrest the impacts of a range of significant multiple *contingency events* (affecting up to 90% of the total *power system load*) to allow a prompt restoration or recovery of *power system security*, taking into account under-frequency or under voltage initiated *load shedding* capability provided under *access agreements* or as otherwise;
- (j) to make available to *Users* as appropriate, information about the potential for, or the occurrence of, a situation which could significantly impact, or is significantly impacting on *power system security*.
- (k) to refer to other *Users*, as *Western Power* deems appropriate, information of which *Western Power* becomes aware in relation to significant risks to the *power system* where actions to achieve a resolution of those risks are outside the responsibility or control of *Western Power*;

- (l) to utilise resources and services provided or procured as *ancillary services* or otherwise to maintain or restore the *satisfactory operating state* of the *power system*;
- (m) to co-ordinate the operation of *black start-up facilities* in response to a partial or total *black system* condition sufficient to re-establish a *satisfactory operating state* of the *power system*;
- (n) to interrupt, subject to clause 5.3.2, *User connections* as necessary during emergency situations to facilitate the re-establishment of the *satisfactory operating state* of the *power system*;
- (o) to direct (as necessary) any *User* to take action necessary to ensure, maintain or restore the *power system* to a *satisfactory operating state*;
- (p) to co-ordinate and direct any rotation of widespread interruption of demand in the event of a major *supply* shortfall or disruption;
- (q) to determine the extent to which the levels of *contingency capacity reserves* and *reactive power reserves* are or were appropriate through appropriate testing, auditing and simulation studies;
- (r) to investigate and review all major *transmission network power system* operational incidents and to initiate action plans to manage any abnormal situations or significant deficiencies which could reasonably threaten *power system security*. All *User's* shall co-operate with such action plans at their own cost. Such situations or deficiencies include without limitation:
 - (1) *power system frequencies* outside those specified in the definition of *satisfactory operating state*;
 - (2) *power system voltages* outside those specified in the definition of *satisfactory operating state*;
 - (3) actual or potential *power system* instability; and
 - (4) unplanned/unexpected operation of major *power system* equipment.

5.3.2 Western Power's Obligations

- (a) *Western Power* must use its reasonable endeavours, as permitted under the *Regulations*, including through the provision of appropriate information to *Users* to the extent permitted by law and under this *Code*, to achieve the *Western Power power system* safety and *security responsibilities* in accordance with *power system security* principles and *good electricity industry practice*.
- (b) Where an obligation is imposed on *Western Power* under this Section of the *Code* to arrange or control any act, matter or thing or to ensure that any other person undertakes or refrains from any act, that obligation is limited to a requirement for *Western Power* to use reasonable endeavours as permitted under the *Regulations*, including to give such *directions* as are within its powers, to comply with that obligation.
- (c) If *Western Power* fails to arrange or control any act, matter or thing or the acts of any other person notwithstanding the use of *Western Power's* reasonable endeavours, *Western Power* will not be taken to have breached such obligation.
- (d) *Western Power* must make accessible to *Users* such information as:
 - (1) *Western Power* considers appropriate;

- (2) *Western Power* is permitted to disclose in order to assist *Users* to make appropriate market decisions related to open access to *Western Power's* transmission networks; and
- (3) *Western Power* is able to disclose to enable *Users* to consider initiating procedures to manage the potential risk of any necessary action by *Western Power* to restore or maintain power system security,

provided that, in doing so, *Western Power* must use reasonable endeavours to ensure that such information is available to those *Users* who request the information on an equivalent basis.

- (e) In the event that *Western Power*, in its reasonable opinion for reasons of safety to the public, *Western Power* personnel, *Users'* equipment or *Western Power* equipment or for power system security, needs to interrupt supply to any *User*, *Western Power* will (time permitting) consult with the relevant *User* prior to executing that interruption.
- (f) *Western Power* must arrange controls, monitoring and secure communication systems which are appropriate in the circumstances to facilitate a manually initiated, rotational load shedding and restoration process which may be necessary if there is, in *Western Power's* opinion, a prolonged major power system disruption.

5.3.3 User Obligations

- (a) All *Users* must co-operate with and assist *Western Power* in the proper discharge of the *Western Power* power system security responsibilities.
- (b) All *Users* must operate their facilities and equipment in accordance with any reasonable direction given by *Western Power*.
- (c) All *Users* must provide automatic interruptible load in accordance with clause 2.4.
- (d) *User's* must provide their interruptible load in manageable blocks spread over a number of steps within under-frequency bands from 49.0 Hz down to 47.0 Hz as nominated by *Western Power*.

5.4 POWER SYSTEM FREQUENCY CONTROL

5.4.1 Power System Frequency Control Responsibilities

Western Power must use its reasonable endeavours to:

- (a) control the power system frequency and associated time error; and
- (b) ensure that the power system frequency operating standards set out in this Code are achieved.

5.4.2 Operational Frequency Control Requirements

To assist in the effective monitoring of power system frequency by *Western Power* the following provisions apply:

- (a) The power to control and direct the output of all generating units and supply to loads is given to *Western Power* pursuant to clause 5.9.
- (b) Each *User* must ensure that all of its generating units have automatic and responsive turbine speed control systems and automatic load control schemes in accordance with

- the requirements of clause 3.2, so as to automatically adjust for *changes* in associated *power demand* or loss of *generation* as it occurs through response to the resulting excursion in *power system frequency* and *associated load*.
- (c) *Western Power* must use its reasonable endeavours to arrange to be available and specifically allocated to *regulating duty* such *generating plant* as *Western Power* considers appropriate which can be automatically controlled or directed by *Western Power* to ensure that normal *load variations* do not result in *frequency deviations* outside the limitations specified in clause 5.2.1(a).
 - (d) *Western Power* must use its reasonable endeavours to arrange *ancillary services* and contractual arrangements associated with the availability, responsiveness and control of necessary *contingency capacity reserve* and the rapid *unloading* of *generation* as may be reasonably necessary to cater for the impact on the *power system frequency* of potential *power system* disruptions ranging from the *critical single credible contingency event* to the most serious *contingency events*.
 - (e) *Western Power* must use its reasonable endeavours to ensure that adequate *facilities* are available and are under the *direction* of *Western Power* to allow the managed recovery of the *satisfactory operating state* of the *power system*.

5.5 CONTROL OF TRANSMISSION NETWORK VOLTAGES

5.5.1 Transmission Network Voltage Control

- (a) *Western Power* must determine the adequacy of the capacity to produce or absorb *reactive power* in the control of the *transmission network voltages*.
- (b) *Western Power* must assess and determine the limits of the operation of the *transmission network* associated with the avoidance of *voltage* failure or collapse under *credible contingency event* scenarios.
- (c) The determination referred to in clause 5.5.1(b) must include a review of the voltage stability of the *transmission network*.
- (d) The limits of operation of the *transmission network* must be translated by *Western Power*, into key location operational *voltage* settings or limits, *transmission line* capacity limits, *reactive power* production (or absorption) capacity or other appropriate limits to enable their use by *Western Power* in the maintenance of *power system security*.
- (e) *Western Power* must use its reasonable endeavours to maintain *voltage* conditions throughout the *transmission network* in accordance with the technical requirements specified in Section 2.
- (f) *Western Power* must use its reasonable endeavours to arrange the provision of *reactive power facilities* and *power system voltage stabilising facilities* through:
 - (1) contractual arrangements for *ancillary services* with appropriate *Users*;
 - (2) obligations on the part of *Users*; or under their *access agreements*;
 - (3) provision of such *facilities* by *Western Power*.
- (g) Without limitation, such *reactive power facilities* may include:
 - (1) *synchronous generator voltage controls* usually associated with *tap-changing transformers*; or *generator AVR* setpoint control (rotor current adjustment);
 - (2) *synchronous condensers* (compensators);

- (3) *static VAR compensators (SVC);*
- (4) *shunt capacitors;*
- (5) *shunt reactors;*
- (6) *series capacitors.*

5.5.2 Reactive Power Reserve Requirements

- (a) *Western Power must use its reasonable endeavours to ensure that sufficient reactive power reserve is available at all times to maintain or restore the power system to a satisfactory operating state after the most critical contingency event as determined by previous analysis or by periodic contingency analysis by Western Power.*
- (b) *If voltages are outside acceptable limits, and the means of voltage control set out in this clause 5.5 are exhausted, Western Power must take all reasonable actions, including to direct changes to demand (through selective load shedding from the power system), additional generation operation or reduction in the transmission line flows but only to the extent necessary to restore the voltages to within the relevant limits. A User must comply with any such direction.*

5.5.3 Audit and Testing

Western Power must arrange, co-ordinate and supervise the conduct of appropriate tests to assess the availability and adequacy of the provision of reactive power devices to control and maintain power system voltages under both satisfactory operating state and contingency event conditions.

5.6 PROTECTION OF POWER SYSTEM EQUIPMENT

5.6.1 Power System Fault Levels

- (a) *Western Power must determine the fault levels at all busbars of the Western Power transmission network as described in clause 5.6.1(b);*
- (b) *Western Power must ensure that there is information available about the transmission network which will allow the determination of fault levels for normal operation of the power system. Western Power will make available on request the credible contingency events which Western Power considers may affect the configuration of the power system so that Western Power and Users can identify their busbars which could potentially be exposed to a fault level which exceeds the fault current ratings of the circuit breakers and other equipment associated with that busbar.*

5.6.2 Power System Protection Co-Ordination

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

5.6.3 Audit and Testing

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

5.6.4 Short-Term Thermal Ratings of Power System

- (a) *Western Power* may act so as to use, or require or recommend actions which use the full extent of the thermal ratings of *transmission elements* to maintain *power system security*, including the short-term ratings (being time dependent ratings), as defined by *Western Power* from time to time.
- (b) *Western Power* must use its reasonable endeavours not to exceed the *transmission element* ratings and not to require or recommend action which causes those ratings to be exceeded.

5.6.5 Partial Outage of Power Protection Systems

- (a) Where there is an *outage* of one *protection* of a *transmission element*, *Western Power* must determine, the most appropriate action. Depending on the circumstances the determination may be:
 - (1) to leave the *transmission element* in service for a limited duration;
 - (2) to take the *transmission element* out of service immediately;
 - (3) to install or direct installation of a temporary *protection*;
 - (4) to accept a degraded performance from the *protection*, with or without additional operational measures or temporary *protection* measures to minimise *power system* impact; or
 - (5) to operate the *transmission element* at a lower capacity.
- (b) If there is an *outage* of both *protections* on a *transmission element* and *Western Power* determines this to be an unacceptable risk to *power system security*, *Western Power* must take the *transmission element* out of service as soon as possible and advise any affected *Users* immediately this action is undertaken.
- (c) Any affected *User* must accept a determination made by *Western Power* under this clause 5.6.5.

5.7 POWER SYSTEM STABILITY CO-ORDINATION

5.7.1 Stability Analysis Co-Ordination

- (a) *Western Power* must use its reasonable endeavours to ensure that all necessary calculations associated with the stable operation of the *power system* as described in clause 2.3 and for the determination of settings of equipment used to maintain that stability are carried out and to co-ordinate these calculations and determinations.
- (b) *Western Power* must facilitate establishment of the parameters and endorse the installation of *power system* devices which are approved by *Western Power* to be

necessary to assist the stable operation of the *power system* .

5.7.2 Audit and Testing

Western Power must arrange, co-ordinate and supervise the conduct of such inspections and tests as it deems appropriate to assess the availability and adequacy of the devices installed to maintain *power system* stability.

5.8 POWER SYSTEM SECURITY OPERATIONS

5.8.1 Users' Advice

A *User* must promptly advise *Western Power* at the time that the *User* becomes aware of any circumstance which could be expected to adversely affect the secure operation of the *power system* or any equipment owned or under the control of the *User*.

5.8.2 Protection or Control System Abnormality

- (a) If a *User* becomes aware that any relevant *protection* or *control system* is defective or unavailable for service, that *User* must advise *Western Power*. If *Western Power* considers it to be a threat to *power system security*, *Western Power* may direct that the equipment protected or operated by the relevant *protection* or *control system* be taken out of operation or operated as *Western Power* directs.
- (b) A *User* must comply with a *direction* given by *Western Power* under clause 5.8.3(a) at no cost to *Western Power*.

5.8.3 Western Power's Advice on Power System Emergency Conditions

- (a) *Western Power* must advise affected or potentially affected *Users* of all relevant details promptly after *Western Power* becomes aware of any circumstance with respect to the *power system* which, in the reasonable opinion of *Western Power*, could be expected to materially adversely affect *supply* to or from *Users*.
- (b) Without limitation, such circumstances may include:
 - (1) electricity capacity shortfall, being a condition where there is insufficient *transmission* or *supply* options available to enable the secure *supply* of the total *load* in a *region*;
 - (2) unexpected disruption of *power system security*, which may occur when:
 - (i) an unanticipated major *power system contingency event* occurs; or
 - (ii) significant environmental or similar conditions, including weather, storms or fires, are likely to, or are affecting the *power system*; or
 - (3) *black system* condition.

5.8.4 Managing a Power System Contingency Event

- (a) During the period when the *power system* is affected by a *contingency event* *Western Power* must carry out actions, in accordance with the guidelines set out in this *Code*:
 - (1) identify the impact of the *contingency event* on *power system security* in terms

- (2) of the capability of the *transmission network*;
 - (2) identify and implement the actions required in each affected *region* to restore the *power system* to its *satisfactory operating state*.
- (b) When *contingency events* lead to potential or actual electricity *supply* shortfall events, *Western Power* must follow the procedures outlined in clause 5.8.

5.8.5 Managing Electricity Supply Shortfall Events

- (a) If, at any time, there are insufficient *transmission supply* options available to securely *supply total load* in a *region*, then, *Western Power* may undertake all or any of the following:
- (1) recall of *transmission equipment outages*;
 - (2) *disconnect* one or more points of *load connection* as *Western Power* considers necessary;
 - (3) direct a *User* to take such steps as are reasonable to immediately reduce its *load*. Any temporary *load* reduction shall be such that preference in supply is given where necessary, to domestic customers, then commercial customers and finally industrial customers.
- (b) A *User* must use all reasonable endeavours to comply with a notice given under clause 5.8.5 (a)(3).
- (c) If there is a major *supply* shortfall, *Western Power* must implement, to the extent practicable, a sharing of *load shedding* across *interconnected regions* up to the *power transfer capability* of the *network*.

5.8.6 Directions by Western Power Affecting Power System Security

Subject to regulation 30 of the *Regulations* and *Western Power* giving a *User* a reasonable period of time to take appropriate action:

- (a) *Western Power* may give reasonable *directions* to any *User*:
- (1) requiring the *User* to do any act or thing which *Western Power* considers reasonably necessary to ensure, to maintain or re-establish the *power system* in a *satisfactory operating state*; or
 - (2) for or with respect to, reasonable standards and procedures to be observed by the *User*:
 - (i) to achieve *power system security* in any region or, where there may be risk to equipment forming part of the *power system*, security of equipment, any other person; or
 - (ii) to maintain *voltage* levels or *reactive power reserves* through the part of the *power system* in a *region*
- (b) A *User* must use all reasonable endeavours to comply within a reasonable period of time with any such *directions* given to it by *Western Power*. If a *User* does not comply with a *direction* within a reasonable period of time and as such a *satisfactory operating state* cannot be re-established, *Western Power* may *disconnect* the *User* without further recourse.

5.8.7 Disconnection of Generating Units and/or Associated Loads

- (a) Where, under the *Regulations* or this *Code*, *Western Power* has the authority or responsibility to *disconnect* either a *generating unit* or its *associated load*, then it may do so (either directly or through any agent) as described in clause 4.3.
- (b) The relevant *User and associated load* must provide all reasonable assistance to *Western Power* for the purpose of such *disconnection*.

5.8.8 Emergency Black Start-up Facilities

Users, other than non-dispatchable generators, such as wind generators, must ensure they have sufficient *facilities* available and operable, or make alternative arrangements, for their own black start-up requirements.

5.8.9 Local Black System Procedures

- (a) *User, other than non-dispatchable generators,* must develop the draft *black system procedures* for each of its *power stations* and must submit those procedures for approval by *Western Power*.
- (b) *Western Power* may request amendments to a *User's* draft *black system procedures* or any proposed changes as *Western Power* reasonably considers necessary by notice in writing to the *User*, where use is to be made of the *transmission network*.
- (c) If *Western Power* and a *User* are unable to agree on the amendments, the matter may be dealt with under the Dispute Resolution and Electricity Referee *Regulations*.

5.8.10 Black System Start-up

- (a) *Western Power* must advise a *User* if, in *Western Power's* reasonable opinion, there is a *black system* condition which is affecting, or which may affect, that *User*.
- (b) If a *User* is providing *black start-up facilities* under an *ancillary services agreement* with another *User*, then the *local black system procedures* for that *User* must be consistent with this *Code* and their *access agreements*.
- (c) *Western Power* may by notice in writing to the relevant *User* require such amendments to the *local black system procedures* for a *User* which, in its reasonable opinion, are needed for consistency with:
 - (1) actual *power system* requirements; or
 - (2) if the *User* is providing *black start-up facilities* to another *User* under an *ancillary services agreement*, the relevant connection *agreement or Regulation*.
- (d) If *Western Power* advises a *User* of a *black system* condition, and/or if the terms of the relevant *local black system procedures* require the *User* to take action, then the *User* must comply with the agreed requirements of the *local black system procedures*.
- (e) If there is a *black system* condition, then a *User/ Customer* must comply with *Western Power's* instructions with respect to the timing and magnitude of *load* restoration, as well as subsequent *load* movements or *disconnections*.

5.8.11 Review of Operating Incidents

- (a) *Western Power* must conduct reviews of significant operating incidents or deviations from normal operating conditions in order to assess the adequacy of the provision and response of *facilities* or services, and the appropriateness of actions taken to restore or maintain *power system security*.
- (b) For all cases where *Western Power* has been responsible for the *disconnection* of a *User*, a report of the review carried out must be provided by *Western Power* to the *User* advising of the circumstances requiring that action.
- (c) A *User* must co-operate in any such review conducted by *Western Power* (including making available relevant records and information).
- (d) A *User* must provide to *Western Power* such information relating to the performance of its equipment during and after particular *power system* incidents or operating condition deviations as *Western Power* reasonably requires for the purposes of analysing or reporting on those *power system* incidents or operating condition deviations.
- (e) *Western Power* must provide to a *User* such information or reports relating to the performance of that *User's* equipment during *power system* incidents or operating condition deviations as that *User* reasonably requests and in relation to which *Western Power* is required to conduct a review under this clause.

5.9 POWER SYSTEM SECURITY RELATED MARKET OPERATIONS

5.9.1 Dispatch Related Limitations

A *User* must not, unless in the *User's* reasonable opinion public safety would otherwise be threatened or there would be a material risk of damaging equipment or the environment:

- (a) *dispatch any energy* from a *generating unit*, except:
 - (1) in accordance with the procedures specified in this *Code* and its Technical Requirements for connection; or
 - (2) in accordance with an instruction from *Western Power*; or
 - (3) as a consequence of operation of the *generating unit's* automatic load following scheme approved by *Western Power*; or
 - (4) in accordance with a procedure agreed with *Western Power*; or
 - (5) in connection with a test conducted in accordance with the requirements of this *Code* or a procedure agreed with by *Western Power*;
- (b) adjust the *transformer tap position* or *excitation control system voltage* set-point of a *scheduled generating unit* except:
 - (1) in accordance with an instruction from or by agreement with *Western Power*; or
 - (2) in response to remote control signals given by *Western Power* or its agent; or
 - (3) if, in the scheduled *User's* reasonable opinion, the adjustment is urgently required to prevent material damage to the *User's plant* or associated

- (4) equipment, or in the interests of safety; or
in connection with a test agreed with *Western Power* and conducted in accordance with this Code or procedures agreed with *Western Power*.
- (c) *energise a connection point* in relation to a *User's generator unit* without prior approval from *Western Power*. This approval must be obtained immediately prior to *energisation*;
- (d) *synchronise a scheduled generating unit* to, or *de-synchronise a scheduled generating unit* from, the *power system* without prior approval from *Western Power* except *de-synchronisation* as a consequence of the operation of automatic *protection* equipment or where such action is urgently required to prevent material damage to *plant* or equipment or in the interests of safety;
- (e) change the *frequency response mode* of a *scheduled generating unit* without the prior approval of *Western Power*; or
- (f) remove from service or interfere with the operation of any *power system* stabilising equipment installed on that *generating unit*.

5.9.2 Commitment of Generating Units

In relation to any *User's generating unit*, the *User* must confirm with *Western Power*, the expected *synchronising* time at least one hour before the expected actual *synchronising* time, and update this advice 5 minutes before *synchronising* unless otherwise agreed with *Western Power*. *Western Power* may require further notification immediately before *synchronisation*.

5.9.3 De-commitment, or Output Reduction, by Users Requiring Standby Power

- (a) Any *User* requiring *standby power* from *Western Power* must notify *Western Power* well in advance. To do this a *User* will have to both apply for it and include it in the *outage* and production plans they submit to *Western Power* in accordance with regulation 31 of the *Regulations*.
- (b) A *User* must confirm with *Western Power* the expected *de-synchronising* time at least one hour before the expected actual *de-synchronising* time, and update this advice 5 minutes before *de-synchronising* unless otherwise agreed with *Western Power*. *Western Power* may require further notification immediately before *de-synchronisation*.
- (c) Information to be confirmed with *Western Power* to *de-commit* a *User's generating unit* if there is to be no automatic and coincident reduction in the *User's associated load* must include:
 - (1) the time to commence decreasing the output of the *generating unit*;
 - (2) the *ramp rate* to decrease the output of the *generating unit*;
 - (3) the time to *de-synchronise* the *generating unit*; and
 - (4) the output from which the *generating unit* is to be *de-synchronised*.
- (d) Any *User* not requiring *standby power* who wishes to take a *generator* out-of-service must first reduce the *associated load* demand by an amount equal to the *generator* output to be reduced. Once the demand has been reduced, the *generator's load* may

be reduced. Clearance must be obtained from *Western Power* before commencing this exercise.

5.9.4 User Plant Changes

A *User* must, without delay, notify *Western Power* of any event which has changed or is likely to change the operational availability or *load* following capability of any of its *generating units*, whether the relevant *generating unit* is *synchronised* or not, as soon as the *User* becomes aware of the event.

5.9.5 Operation, Maintenance and Extension Planning

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

5.10 POWER SYSTEM OPERATING PROCEDURES

5.10.1 Power System Operating Procedures

The *power system operating procedures* are:

- (1) any instructions which may be issued by *Western Power* from time to time relating to the operation of the *power system*; and
- (2) any guidelines issued from time to time by *Western Power* in relation to *power system security*.

5.10.2 Transmission Network Operations

- (a) *Western Power* must conduct or direct operations on the *transmission network* in accordance with the appropriate *power system operating procedures* and *good electricity industry practice*.
- (b) A *User* must observe the requirements of the relevant *power system operating procedures*.
- (c) *Users* must operate their equipment interfacing with the *transmission network* in accordance with the requirements of the *Regulations*, this *Code*, any applicable *access agreement*, *ancillary services agreement*, and *Western Power's* Electrical Safety Instructions and procedures.
- (d) *Users* must ensure that *transmission network* operations performed on their behalf are undertaken by competent persons.

5.10.3 Switching of Reactive Power Facilities

- (a) *Western Power* may instruct a *User* to place reactive *facilities* belonging to or controlled by that *User* into or out of service for the purposes of maintaining *power system security* where prior arrangements concerning these matters have been made between *Western Power* and a *User*.
- (b) Without limitation to its obligations under such prior arrangements, a *User* must use reasonable endeavours to comply with such an instruction given by *Western Power* or its authorised agent.

5.11 POWER SYSTEM SECURITY SUPPORT

5.11.1 Remote Control and Monitoring Devices

- (a) All remote control, operational *metering* and monitoring devices and local circuits as described in Section 3, must be installed and maintained by a *User* in accordance with the standards and protocols determined and advised by *Western Power* (for use in the *Western Power control centre*) for each:
- (1) *generating unit and associated load connected to the transmission network;*
 - (2) *substation connected to the transmission network;* and
 - (3) *ancillary service provided by that User.*
- (b) The provider of any *ancillary services* must arrange the installation and maintenance of all *remote control equipment* and *remote monitoring equipment* in accordance with the standards and protocols determined by *Western Power* for use in the *Western Power control centre*.
- (c) The controls and monitoring devices must include the provision for indication of *active power* and *reactive power* output, and to signal the status and any associated alarm condition relevant to achieving adequate *protection* control and indication of the *transmission network*, and the *User's plant* active and reactive output consumption.

5.11.2 Operational Control and Indication Communication Facilities

- (a) In accordance with clauses 3.2.5.1, 3.2.5.2, 3.3.8.1 and 3.3.8.2, as applicable, each *User* must provide and maintain the necessary primary and, where nominated by *Western Power*, back-up communications *facilities* for control, operational *metering* and indication from the relevant local sites to the appropriate interfacing termination as nominated by *Western Power*.

5.11.3 Power System Voice/Data Operational Communication Facilities

- (a) *Users* must advise *Western Power* of each nominated position for the purposes of giving or receiving *operational communications* in relation to each of its *facilities*. The position so nominated must be that responsible for undertaking the operation of the relevant equipment of the relevant *User*.
- (b) Contact personnel details which must be forwarded to *Western Power* include:
- (1) title of contact position;
 - (2) the telephone numbers of that position;
 - (3) the telephone numbers of other available communication systems in relation to the relevant *facility*;
 - (4) a facsimile number for the relevant *facility*; and
 - (5) an electronic mail address for the relevant *facility*.
- (c) Each *User* must provide, for each nominated position, two independent telephone communication systems fully compatible with the equipment installed at the appropriate *control centre* nominated by *Western Power*.
- (d) Each *User* must maintain both telephone communication systems in good repair and

- must investigate faults within 4 hours, or as otherwise agreed with *Western Power*, of a fault being identified and must repair or procure the repair of faults promptly.
- (e) Each *User* must establish and maintain a form of electronic mail facility as approved by *Western Power* for communication purposes (such approval may not be unreasonably withheld).
 - (f) *Western Power* must advise all *Users* of nominated persons for the purposes of giving or receiving *operational communications*.
 - (g) Contact personnel details to be provided by *Western Power* include title, telephone numbers, a facsimile number and an electronic mail address for the contact person.

5.11.4 Records of *Power System Operational Communication*

- (a) *Western Power* and *Users* must record each telephone *operational communication* in the form of log book entries or by another auditable method which provides a permanent record as soon as practicable after making or receiving the *operational communication*.
- (b) Records of *operational communications* must include the time and content of each communication and must identify the parties to each communication.
- (c) Voice recordings of telephone *operational communications* may be undertaken by *Western Power* and *Users*. *Western Power* and the *User* must ensure that when a telephone conversation is being recorded under this clause, the persons having the conversation receive an audible indication that the conversation is being recorded in accordance with relevant statutory *Regulations*. Voice recordings may be used as an alternative to written logs.
- (d) *Western Power* and *Users* must retain all *operational communications* records including voice recordings for a minimum of 7 years.
- (e) In the event of a dispute involving an *operational communication*, the records of that *operational communication* maintained by, or on behalf of *Western Power* will constitute prima facie evidence of the contents of the *operational communication*.

5.11.5 Agent Communications

- (a) A *User* may appoint an agent (called a "*User Agent*") to coordinate operations of one or more of its *facilities* on its behalf, but only with the prior written consent of *Western Power*.
- (b) A *User* which has appointed a *User Agent* may replace that *User Agent* but only with the prior written advice to *Western Power*.
- (c) *Western Power* may only withhold its consent to the appointment of a *User Agent* under clause 5.11.5(a), if it reasonably believes that the relevant person is not suitably qualified or experienced to operate the relevant *facility* at the interface with a *transmission network*.
- (d) For the purposes of the *Regulations* and this *Code*, acts or omissions of a *User Agent*

are deemed to be acts or omissions of the relevant *User*.

- (e) *Western Power* and its *representatives* (including authorised agents) may:
 - (1) rely upon any communications given by a *User Agent* as being given by the relevant *User*; and
 - (2) rely upon any communications given to a *User Agent* as having been given to the relevant *User*.
- (f) *Western Power* is not required to consider whether any instruction has been given to a *User Agent* by the relevant *User* or the terms of those instructions.

5.12 NOMENCLATURE STANDARDS

- (a) A *User* must use the *nomenclature standards* for *transmission* equipment and apparatus as agreed with *Western Power* or failing agreement, as determined by *Western Power*.
- (b) A *User* must use reasonable endeavours to ensure that its *representatives* comply with the *nomenclature standards* in any *operational communications* with *Western Power*.
- (c) A *User* must ensure that name plates on its equipment relevant to operations at any point within the *power system* conform to the requirements set out in the *nomenclature standards*.
- (d) A *User* must use reasonable endeavours to ensure that nameplates on its equipment relevant to operations within the *power system* are maintained to ensure easy and accurate identification of equipment.
- (e) A *User* must ensure that technical drawings and documentation provided to *Western Power* comply with the *nomenclature standards*.
- (f) ***Western Power* may, by notice in writing, request a *User* to change the existing numbering or nomenclature of *transmission* equipment and apparatus of the *User* for purposes of uniformity, and the *User* must comply with such request provided that if the existing numbering or nomenclature conforms with the *nomenclature standards*, *Western Power* must pay all reasonable costs incurred in complying with the request.**

6 METERING

6.1 INTRODUCTION

6.1.1 Application of the Metering Section

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

6.1.2 Purpose of Metering Section

- (a) The purpose of this section is to set out the rights and obligations of *Users* and *Western Power*.
- (b) This section sets out provisions relating to:
 - 1) *tariff metering installations* used for the measurement of *active energy* and *reactive energy*, imported and/or exported;
 - 2) *check metering installations*;
 - 3) collection of *tariff metering data*;
 - 4) provision, installation and maintenance of equipment;
 - 5) accuracy of *tariff metering equipment*;
 - 6) testing requirements;
 - 7) security and rights of access to *tariff metering data and equipment*; and
 - 8) provision of *tariff metering data*.

6.1.3 Principles of Metering Section

The key principles adopted in this section are:

- (a) each *connection point* must have a *tariff metering installation*;
- (b) the type of *tariff metering installation* at each *tariff metering point* is to be determined by *Western Power* in accordance with the annual amount of *energy* passing through that *tariff metering point*;
- (c) *Western Power* will have responsibility for the provision and installation of *tariff metering* unless the *User* elects to provide and install the *tariff metering*, other than the *tariff meters*, which will be provided and installed by *Western Power*;
- (d) *Western Power's* Metering & Testing Section will install the *tariff meters* or the *tariff metering*, and will commission and maintain the *tariff metering* on the basis of it being an independently certified *NATA* registered laboratory.

- (e) *Western Power's* Metering & Testing Section may offer to install a *check meter*, or *check meters*, or *check metering*, and commission and maintain *check metering* on behalf of the *User*.
- (f) *Western Power* will own the *tariff metering installation* and the *User* will be required to make a non-refundable capital contribution to the cost of the installation.
- (g) All costs associated with the auditing and maintenance of a *tariff metering installation* will be borne by the *User*.
- (h) *Western Power* must ensure that the accuracy of each component of a *tariff metering installation* complies with its accuracy class.
- (i) *energy data* is to be based on units of wathours *active energy* and varhours *reactive energy*;
- (j) *Western Power* will make *tariff metering data* available to each *User*, subject to confidentiality requirements.
- (k) The *tariff meters* used will make provision for signals comprising energy usage information to be available via volt free relay contacts at the *tariff metering location*.
- (l) The specifications for the *tariff metering voltage* and *current transformers* will make provision for secondary *voltages* and currents to allow the *User* to readily install *check metering*, if required by the *User*.
- (m) Historical *tariff metering data* is to be retained for a minimum of 7 years.
- (n) *Western Power* will audit *tariff metering* when requested.

6.2 RESPONSIBILITY FOR METERING INSTALLATION

6.2.1 Responsibility of *Western Power*

- (a) No later than 20 *business days* after receiving a request for the provision of a *tariff metering installation*, or a *tariff metering installation* and a *check metering installation* from a prospective *User*, *Western Power* shall provide a quotation and any conditions on which the offer is made and also advise the *User* of its right to provide and install certain *tariff metering* components in accordance with Attachment 4 9 and *Western Power's tariff metering specifications*.
- (b) If the *User* accepts the offer, *Western Power* has the responsibility for the provision, installation, commissioning and maintenance of the *tariff metering* equipment in accordance with Attachment 4 and *Western Power's tariff metering specifications*.

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

- (a) If the *User* does not accept the offer made by *Western Power* to provide a *tariff metering installation*, the *User* will be responsible for the provision and installation of the *tariff metering*, except for the *tariff meters* in accordance with Attachment 4 9 and

Western Power's tariff metering specifications and the *check metering*, if required by the *User*.

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

6.2.3 Other Responsibilities

- (a) *Western Power* must ensure that the *tariff metering installation* is provided, installed and maintained in accordance with Attachment 4 9 and *Western Power's tariff metering specifications*.
- (b) The *User*, if providing and installing *tariff metering equipment*, must ensure that the equipment complies with Attachment 4 and *Western Power's tariff metering specifications* and that prior to installation, the equipment which is involved in measurement of energy, other than the *check meters*, is submitted to *Western Power* for testing for compliance with *Western Power's tariff metering specifications*.

6.3 METERING INSTALLATION ARRANGEMENTS

6.3.1 Metering Installation Components

- (a) A *tariff metering installation* must comply with the requirements of the National Standards (Weight & Measures) Act in regard to being a measuring device which is used for trade or legal purposes.
- (b) A *tariff metering installation* must:
 - 1) contain a measuring device for *active* and *reactive energy* and a visible display of all *tariff metering data* as per AS1284;
 - 2) be accurate in accordance with Attachment 4 9;
 - 3) have electronic data transfer *facilities*;
 - 4) be secure in accordance with *Western Power's tariff metering specifications*;
 - 5) have electronic data recording *facilities* for *active* and *reactive energy* flows;
 - 6) be capable of separately registering and recording energy import and export where bi-directional energy flows occur;
 - 7) be capable of providing *tariff metering data* to a communication system; and
 - 8) include a communication system for two way communications with *Western Power*.
- (c) A *tariff metering installation* will consist of combinations of, but is not limited to, the following:
 - 1) *current transformer*;

- 2) *voltage transformers*;
 - 3) *secure and protected wiring*;
 - 4) *tariff meter* panels on which the *tariff meters* and communication equipment are mounted;
 - 5) *series tariff meters* (two off);
 - 6) communication equipment such as modem, Public Switched Telephone Network connection, isolation, radio transmitter and receiver, data link, or power line carrier equipment;
 - 7) *test links and fusing*;
 - 8) *energy and status signals*;
 - 9) *summation equipment*;
 - 10) *tariff metering enclosure*;
 - 11) *marshalling boxes*; and
 - 12) *tariff metering unit*.
- (d) The *tariff metering installation* is exclusively for *tariff metering* other than the provision of energy and status signals which may be provided to the *User* for other purposes.

6.3.2 Use of Meters

- (a) *Tariff metering data* will be used by *Western Power* as the primary source of billing data.
- (b) The readings of the *series tariff meters* will be averaged to obtain a reading.
- (c) If the *series tariff meters* readings differ by more than 1%, then one of the readings will be discarded for the purpose of determining the reading.
- (d) When readings differ by more than 1% and it is not self evident which reading is correct, a determination will be made by reference to *check metering*, if provided, or if not, by an on site audit.
- (e) Where appropriate *check metering data* is available, it will be used if both *tariff meters* fail.

6.3.3 Metering Type and Accuracy

- (a) The accuracy for a *tariff metering installation* and the requirements for a *tariff metering installation* which must be installed at each *tariff metering point* must be in accordance with Attachment 9 and *Western Power's tariff metering specifications*.
- (b) A *check metering installation* is not required, but if provided by an *User* it may use the *voltages* and currents provided by the *tariff metering voltage transformers* and *current transformers*. The *tariff meter* or *tariff meters* will be of the same class as the *tariff meters*. If the *User* elects to provide separate *current transformers* and *voltage transformers* they must comply with clause 6.2.3(b).

6.3.4 Data Collection System

- (a) *Western Power* must ensure that an appropriate communication system is installed to each *tariff metering installation*.
- (b) *Western Power* must establish processes for the collection of *tariff metering data* from each *tariff metering installation* for storage in a *tariff metering data base* in accordance with *Western Power's tariff metering specifications*.
- (c) *Western Power* may obtain *tariff metering data* directly from a *tariff metering installation*.

6.3.5 Payment for Metering

- (a) The *User* is responsible for payment of all costs associated with the provision, installation, commissioning, maintenance, routine testing and inspection, routine audits, downloading of *tariff metering data*, processing and account resolution for a *tariff metering installation*.
- (b) The cost of requisition testing and audits must be borne by the party requesting the test or audit, except where the *tariff metering installation* is shown not to comply with this section, in which case *Western Power* must bear the cost.

6.4 REGISTER OF METERING INFORMATION

6.4.1 Metering Register

- (a) As part of the *tariff metering database*, *Western Power* must maintain a *tariff metering register* of all *User tariff metering installations* and *check metering installations* which provide tariff data.
- (b) The *tariff metering register* for a particular *User's tariff metering installation* must be made available to the *User* on request.

6.4.2 Meter Register Discrepancy

- (a) If a discrepancy is noted between the *User's* installation and the *tariff metering register*, *Western Power* must correct the discrepancy within 2 days.
- (b) If as a result of the correction of the *tariff metering register* it indicates that the *tariff metering installation* or *check metering installation* does not comply with the requirements of this section, *Western Power* must use its reasonable endeavours to rectify the situation in regard to the *tariff metering installation*. If the *check metering installation* does not comply with the requirement of this section, reference to it will be deleted from the *tariff metering register*.

6.5 TESTING OF METERING INSTALLATION

6.5.1 Responsibility for Testing

- (a) Testing of a *tariff metering installation* must be carried out in accordance with *Western Power's tariff metering specifications*.
- (b) A *User* may request *Western Power* to arrange for the testing of any *User's tariff metering installation* and *Western Power* must not refuse any reasonable request.
- (c) The *User* will have the right to be present at any such testing.
- (d) *Western Power* must arrange for sufficient audit testing of *User tariff metering installations* to satisfy itself that each *tariff metering installation* conforms to the requirements of this section.
- (e) *Western Power* must have unfettered access to any *User's tariff metering installation* at any time for the purpose of testing the *tariff metering installation*.

6.5.2 Actions in Event of Non-Compliance

- (a) If a *tariff metering installation* does not comply with the requirements of this section, *Western Power* must as soon as practical advise the *User* and arrange for the *tariff metering installation* to be made compliant with the requirements of this section.
- (b) *Western Power* must in conjunction with the *User* make appropriate corrections to the *tariff metering data* to take account of any errors as a result of the non-compliance found in 6.5.2(a).

6.5.3 Audits of Metering Data

- (a) A *User* may request *Western Power* to conduct an audit to determine consistency between the data held in the *tariff metering database* and the *tariff metering data* held in the *User's tariff metering installation*.
- (b) If there is an inconsistency between the data held in a *tariff metering installation* and the data held in the *tariff metering database*, the data held in the *tariff metering installation* is to be taken as prima facie evidence of the *tariff metering data*.

6.6 RIGHTS OF ACCESS TO DATA

- (a) The only persons entitled to have either direct or remote access to *tariff metering data* from a *tariff metering installation*, the *tariff metering database* or the *tariff metering register* in relation to a *tariff metering point* are:
 - 1) *Western Power*; and
 - 2) The *User* whose account statement relates to energy measured at that *tariff metering point*.
- (b) Electronic access to *tariff metering data* from a *tariff metering installation* shall only be provided where appropriate multi level password *tariff meters* are installed and the

appropriate software is obtained by the *User*.

6.7 SECURITY OF METERING INSTALLATIONS

6.7.1 Security of Metering Equipment

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

6.7.2 Security Controls

- (a) *Western Power* is responsible for the security of *tariff metering data* held in the *tariff metering installation* and shall prevent local or remote access by suitable passwords and/or other security devices in accordance with clause 6.7.1.
- (b) *Western Power* must keep records of electronic passwords secure.
- (c) *Western Power* may allocate “read-only” passwords to *User*’s where the *tariff meters* installed have provision for multi-level passwords.

6.7.3 Changes to Metering Equipment, Parameters and Settings

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

6.8 PROCESSING OF METERING DATA FOR SETTLEMENT PURPOSES

6.8.1 Metering Databases

- (a) *Western Power* will create, maintain and administer a *tariff metering database* containing information for each *User tariff metering installation*.
- (b) The *tariff metering database* must include original energy readings and substitutional calculated values.

6.8.2 Remote Acquisition of Data

- (a) *Western Power* is responsible for the remote acquisition of *tariff metering data* and for storing and processing this data for *settlement* purposes.
- (b) If remote acquisition becomes unavailable, *Western Power* is responsible for obtaining the relevant *tariff metering data* from the *tariff meters*.

6.8.3 Periodic Energy Metering

Data relating to the amount of *active* and *reactive energy* passing through a *tariff metering installation* is normally collated in trading intervals of between 28 and 35

days inclusive unless it has been agreed between the *User* and *Western Power* that some other period will apply either on an ongoing or once-off basis.

6.8.4 Data Validation

- (a) At commissioning, *Western Power* will validate, on-site, the data being recorded by a *tariff metering installation* against the measurement of basic parameters and the *User's* estimation of *load*.
- (b) *Western Power* will compare the data from each of the series *tariff meters* each reading interval as required in clause 6.9.3. Any discrepancy greater than twice the tolerance for the class of *tariff meter* in use will require the *tariff metering installation* to be audited by *Western Power*.
- (c) As a result of this audit, all or part of the data from either *tariff meter* may be discarded by *Western Power*. For the purpose of *settlement*, *check metering data*, if available, may be substituted either in whole or part for some or whole of the *tariff metering* readings.
- (d) *Settlement* will normally be based on the average of the readings of the service *tariff meters*.

6.8.5 Errors Found in Metering Tests, Inspections or Audits

- (a) If a *tariff metering installation* test, inspection or audit demonstrates that a component of the *tariff metering* has errors in excess of those permitted by its class and it is not possible to determine from other data when the error occurred, the error will be deemed to have occurred at a time halfway between the time the error was found and the time of the previous most recent test or inspection which demonstrated that the installation complied with Attachment 9 and *Western Power's tariff metering specifications*.
- (b) If a test or audit of a *tariff metering installation* demonstrates that a component of a *tariff metering system* has an error less than 1.5 times the error permitted for that component, then no substitution of readings is required.

6.9 CONFIDENTIALITY

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

6.10 METER TIME

- (a) All *tariff metering installation* clocks are to be referenced to West Australian Standard *Time* and maintained to a standard of accuracy as required by AS1284.
- (b) The *tariff metering database* must be set within an accuracy of 1 second of Western Australian Standard *Time*.

7. DEROGATIONS

7.1 PURPOSE AND APPLICATION

- (a) This Section prevails over all other Sections of this *Code*.
- (b) *Derogations* of *Users* are:
- (1) those provisions of the other Sections of the *Code* which shall not apply either in whole or part to particular *Users* or potential *Users* or others in relation to their *facilities* for a fixed or indeterminate period;
 - (2) any provisions which substitute for those provisions which are not to apply; and
 - (3) applicable only to that particular *User* or potential *User*.
- (c) *Derogations* are for the purpose of:
- (1) enabling *Users* to effect an orderly transition to the provisions of the *Code* from those provisions currently applying;
 - (2) providing specific exemptions from the *Code* for pre-existing arrangements which *Western Power* determines must continue beyond a specific transition period; and
 - (3) providing specific exemptions from the *Code* for future arrangements which *Western Power* determines to be acceptable.
- (d) Applications for *derogations* must be submitted to and processed by *Western Power* in accordance with regulations 26(6), 26(7), 26(8), 26(9), 26(10) and 26(11) of the *Regulations*.

7.2 TRANSMISSION NETWORKS AND FACILITIES EXISTING AT 7 DECEMBER 2004

All *plant* and equipment in the *South West Interconnected System* and the *North West Interconnected System*, and all *facilities* connected to these *networks* existing **at 7 December 2004 are deemed to comply** with the requirements of this Code. If at any time it is found that an installation is adversely affecting *power system security*, *reliability* of the *power system* and/or the *quality of supply*, the relevant *User* shall be responsible for remedying the problem at its cost.

ATTACHMENT 1

GLOSSARY

In this *Code*, unless the contrary intention appears:

- (a) a word or phrase set out in column 1 of the table below has the meaning set out opposite that word or phrase in column 2 of the table below; and
- (b) a word or phrase defined in the Electricity Corporation Act 1994 or the Electricity Transmission Regulations 1996 has the meaning given in that Act or those *Regulations* (as the case requires), unless redefined in the table below.

access agreement	Has the meaning given in the <i>Regulations</i> .
access application	Has the meaning given in the <i>Regulations</i> .
access services	Has the meaning given in the <i>Regulations</i> .
active energy	A measure of electrical energy flow, being the time integral of the product of <i>voltage</i> and the in-phase component of current flow across a <i>connection point</i> , expressed in Watthours (Wh) and multiples thereof.
active power	The rate at which <i>active energy</i> is transferred.
active power capability	The maximum rate at which <i>active energy</i> may be transferred from a <i>generating unit</i> to a <i>connection point</i> as specified in an <i>access agreement</i> .
agreed capability	In relation to a <i>connection point</i> , the capability to receive or send out <i>active power</i> and <i>reactive power</i> for that <i>connection point</i> determined in accordance with the relevant <i>access agreement</i> .
ancillary services	Has the meaning given in the <i>Regulations</i> .
ancillary services agreement	An agreement covering the provision of <i>ancillary services</i> .
associated load	A <i>load</i> which is normally supplied by a particular <i>generator</i> and is associated with that <i>generator</i> by ownership or some contractual arrangement. The <i>load</i> may be remote from the <i>generator</i> or on-site.
augment, augmentation	Has the meaning given in the <i>Regulations</i> .
Australian Standard (AS)	The most recent edition of a standard publication by Standards Australia (Standards Association of Australia).
automatic reclose equipment	In relation to a <i>transmission line</i> , 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 <i>transmission line</i> .

TECHNICAL CODE
ATTACHMENT 1 – GLOSSARY

back up protection	A <i>protection</i> intended to supplement the main <i>protection</i> in case the latter should be ineffective, or to deal with faults in those parts of the <i>power system</i> that are not readily included in the operating zone of the main <i>protection</i> .
black start capability	In relation to a <i>generating unit</i> , the ability to start and <i>synchronise</i> without using supply from the <i>power system</i> .
black start-up facilities	The <i>facilities</i> required to provide a <i>generating unit</i> with <i>black start-up capability</i> .
black system	The absence of <i>voltage</i> on all or a significant part of the <i>transmission network</i> following a major <i>supply</i> disruption, affecting one or more <i>power stations</i> and a significant number of customers.
breaker fail	In relation to a <i>protection scheme</i> , that part of the <i>protection scheme</i> that protects a <i>User's facilities</i> against the non-operation of a circuit breaker that is required to open.
busbar	A common <i>connection point</i> in a <i>power station substation</i> or a <i>transmission network substation</i> .
business day	Has the meaning given in the <i>Regulations</i> .
capacitor bank	A type of electrical equipment used to generate <i>reactive power</i> and therefore support <i>voltage</i> levels on <i>transmission lines</i> .
cascading outage	The occurrence of an uncontrollable succession of <i>outages</i> , each of which is initiated by conditions (e.g. instability or overloading) arising or made worse as a result of the event preceding it.
change	Includes amendment, alteration, addition or deletion.
check meter	A <i>meter</i> used as a source of <i>metering data</i> for <i>metering installations</i> as specified in section 6.
check metering data	The <i>metering data</i> obtained from a <i>check metering installation</i> .
check metering installation	A <i>metering installation</i> which may be used as the source of <i>metering data</i> for validation in the <i>settlements</i> process.
circuit breaker failure	A circuit breaker will be deemed to have failed if, having received a trip signal from a <i>protection scheme</i> , it fails to interrupt fault current within its design operating time.
Code, Technical Code	This <i>Code</i> called the <i>Technical Code</i> prepared by <i>Western Power</i> under regulation 26 of the <i>Regulations</i> .
Code commencement date	The date given in clause 1.3 of this <i>Code</i> .
commitment	The commencement of the process of starting up and <i>synchronising</i> a <i>generating unit</i> to the <i>power system</i> .

TECHNICAL CODE
ATTACHMENT 1 – GLOSSARY

complementary	In relation to <i>protection</i> , two <i>protection schemes</i> are said to be complementary when, in combination, they provide dependable clearance of faults on <i>plant</i> within a specified time, but with any single failure to operate of the <i>secondary plant</i> , fault clearance may be delayed until the nature of the fault changes.
connect, connected	To form a physical link to or through the <i>transmission network</i> , by direct or indirect connection, so as to have an impact on <i>power system security, reliability and quality of supply</i> .
connection	The physical link between a <i>User</i> and Western Power (via a <i>connection asset</i>) that allows the transfer of electricity from one to the other.
connection agreement	Has the meaning given in the <i>Regulations</i> .
connection asset <i>NB this is the definition of “connection” given in the Regulations. “Connection asset” is not defined in the Regulations.</i>	The electrical equipment that allows the transfer of electricity between the electricity transmission network and an electrical system that is not part of that network. This includes any transformers or switchgear at the point of interconnection (including those that operate at a nominal voltage of less than 66kV) but does not include the lines and switchgear at the connection that form part of the electricity transmission network.
connection point	The agreed point of <i>supply</i> established between <i>Western Power</i> and a <i>User</i> .
constraint, constrained	A limitation on the capability of a <i>network, load</i> or a <i>generating unit</i> preventing it from either transferring, consuming or generating the level of electrical power which would otherwise be available if the limitation was removed.
contingency capacity reserve	Actual <i>active</i> and <i>reactive energy</i> capacity, <i>interruptible load</i> arrangements and other arrangements organised to be available to be utilised on the actual occurrence of one or more <i>contingency events</i> to allow the restoration and maintenance of <i>power system security</i> .
contingency event	An event affecting the <i>power system</i> which <i>Western Power</i> expects would be likely to involve the failure or removal from operational service of a <i>generating unit</i> or <i>transmission element</i> .
control centre	The <i>facility</i> used by <i>Western Power</i> for directing the minute to minute operation of the <i>power system</i> .
controller	Has the meaning given in the <i>Regulations</i> .
control system	Means of monitoring and controlling the operation of the <i>power system</i> or equipment including <i>generating units connected to a transmission</i> .
converter coupled generating unit	A generator uses a machine, device, or system that changes its alternating-current power to alternating-current power acceptable for power system connection.

TECHNICAL CODE
ATTACHMENT 1 – GLOSSARY

credible contingency event	A <i>contingency event</i> the occurrence of which <i>Western Power</i> considers to be reasonably possible in the surrounding circumstances. This will include events such as the disconnection of any single generating unit or transmission line with or without the application of a fault.
critical fault clearance time	Refers to the maximum <i>total fault clearance time</i> that the <i>power system</i> can withstand without one or both of the following conditions arising: 1. Instability (refer to clause 2.3); and 2. Unacceptable disturbance of <i>power system voltage or frequency</i> .
critical credible contingency event	A <i>critical credible contingency event</i> considered by <i>Western Power</i> , in the particular circumstances, is an event that has potential for the most significant impact on the <i>power system</i> at that time. This would generally be the instantaneous loss of the largest <i>generating unit</i> or a fault on a <i>transmission element</i> on the <i>power system</i> . However, this may involve the consideration by <i>Western Power</i> of the impact of the loss of any <i>interconnection</i> under abnormal conditions.
current rating	The maximum current that may be permitted to flow (under defined conditions) through a <i>transmission line</i> or other item of equipment that forms part of a <i>power system</i> .
current transformer (CT)	A <i>transformer</i> for use with <i>meters</i> and/or protection devices in which the current in the secondary winding is, within prescribed error limits, proportional to and in phase with the current in the primary winding.
Customer	A person who engages in the activity of purchasing electricity <i>supplied</i> through a <i>transmission network</i> .
day	Unless otherwise specified, the 24 hour period beginning and ending at midnight Western Standard Time (WST).
decommission, decommit	In respect of a <i>generating unit</i> , ceasing to generate and <i>disconnecting</i> from a <i>network</i> .
derogation	Modification, variation or exemption to one or more provisions of the <i>Code</i> in relation to a <i>User</i> according to Section 7.
de-synchronising/ de-synchronisation	The act of <i>disconnection</i> of a <i>generating unit</i> from the <i>power system</i> , normally under controlled circumstances.
differing principle	Two <i>protections</i> are said to be of <i>differing principle</i> when their functioning is based on different measurement or operating methods, or use similar principles but have been designed and manufactured by different organisations.

TECHNICAL CODE
ATTACHMENT 1 – GLOSSARY

direction	A direction issued by <i>Western Power</i> to any <i>User</i> requiring the <i>User</i> to do any act or thing which <i>Western Power</i> considers necessary to maintain or re-establish <i>power system security</i> or to maintain or re-establish the <i>power system</i> in a <i>reliable operating state</i> in accordance with this <i>Code</i> .
Disconnection, disconnect	The operation of switching equipment or other action so as to prevent the flow of electricity at a <i>connection point</i> .
dispatchable generating unit	A generator that in its satisfactory normal operating state is capable of controlling its real power output within fine limits
dispatch	The act of committing to service all or part of the generation available from a <i>scheduled generating unit</i> .
distribution network	Has the same meaning as ‘distribution system’ in the Electricity Corporation Act 1994.
dynamic performance	The response and behaviour of <i>networks</i> and <i>facilities</i> which are <i>connected</i> to the <i>networks</i> when the <i>satisfactory operating state</i> of the <i>power system</i> is disturbed.
electrical energy loss	<i>Energy</i> loss incurred in the production, transportation and/or use of electricity.
electricity Referee	Has the meaning given in the Dispute Resolution and Electricity Referee Regulations 1997.
electricity transmission capacity	Has the meaning given in the Electricity Corporation Act 1994.
electricity transmission network, network, transmission network	All have the meaning given in the <i>Regulations</i> for <i>electricity transmission network</i> .
embedded generator	A <i>generator</i> which supplies on-site <i>loads</i> or <i>distribution network loads</i> and is <i>connected</i> either indirectly (ie. via the <i>distribution network</i>) or directly to the <i>transmission network</i> .
energise/energisation	The act of operation of switching equipment or the start-up of a <i>generating unit</i> , which results in there being a non-zero <i>voltage</i> beyond a <i>connection point</i> or part of the <i>transmission network</i> .
energy	<i>Active energy</i> and/or <i>reactive energy</i> .
energy data	The data that results from the measurement of the flow of electricity in a power conductor. The measurement is carried out at a <i>metering point</i> .
excitation control system	In relation to a <i>generating unit</i> , the automatic <i>control system</i> that provides the field excitation for the generator of the <i>generating unit</i> (including excitation limiting devices and any power system stabiliser).

TECHNICAL CODE
ATTACHMENT 1 – GLOSSARY

extension	An <i>augmentation</i> that requires the <i>connection</i> of a power line or <i>facility</i> to the <i>transmission network</i> .
facility	A generic term associated with the apparatus, equipment, buildings and necessary associated supporting resources provided at, typically: (a) a <i>power station</i> or <i>generating unit</i> , including <i>black start-up facilities</i> ; (b) a <i>substation</i> or <i>power station substation</i> ; (c) a <i>control centre</i> .
fault clearance time	The time interval between the occurrence of a fault and the fault clearance.
financial year	A period commencing on 1 July in one calendar year and terminating on 30 June in the following calendar year.
frequency	For alternating current electricity, the number of cycles occurring in each second. The term Hertz (Hz) corresponds to cycles per second.
frequency operating standards	The standards which specify the frequency levels for the operation of the <i>power system</i> set out clauses 2.2, and 5.2.1(a).
frequency response mode	The mode of operation of a <i>generating unit</i> which allows automatic changes to the generated power when the <i>frequency</i> of the <i>power system</i> changes.
generated	In relation to a <i>generating unit</i> , the amount of electricity produced by the <i>generating unit</i> as measured at its terminals.
generating plant	In relation to a <i>connection point</i> , includes all equipment involved in generating electrical <i>energy</i> .
generating system	A system comprising one or more <i>generating units</i> .
generating unit	The actual generator of electricity and all the related equipment essential to its functioning as a single entity including step-up <i>transformer</i> <i>connecting</i> it to the <i>power system</i> , and includes <i>embedded generators</i> .
generation	The production of electrical power by converting another form of <i>energy</i> in a <i>generating unit</i> .
generation centre	A geographically concentrated area containing a <i>generating unit</i> or <i>generating units</i> with significant combined generating capability.
Generator	A person who engages in the activity of owning, controlling, or operating a <i>generating system</i> that <i>supplies</i> electricity to, or who otherwise <i>supplies</i> electricity to, a <i>transmission network</i> or <i>distribution network</i> .

TECHNICAL CODE
ATTACHMENT 1 – GLOSSARY

good electricity industry practice	Has the meaning given in the <i>Regulations</i> .
governor system	The automatic <i>control system</i> which regulates the speed and power output of a <i>generating unit</i> through the control of the rate of entry into the <i>generating unit</i> of the primary <i>energy</i> input (for example, steam, gas or water). New terminology is turbine control system.
induction generating unit	The alternating current generator-whose rotor currents are produced by induction from its stator windings and when driven above synchronous speed by an external source of mechanical power converts mechanical power to electric power. It employs a conventional induction machine.
doubly fed induction generating unit	A special wound rotor design of the induction machine, which is effectively a combination of the converter coupled generating unit (rotor side) and conventional induction generating unit (stator side).
instrument transformer	Either a <i>current transformer (CT)</i> or a voltage transformer (<i>VT</i>).
interconnection, interconnector, interconnect, interconnected	A <i>transmission line</i> or group of <i>transmission lines</i> that connects the <i>transmission networks</i> in adjacent <i>regions</i> .
interruptible load	A <i>load</i> which is able to be <i>disconnected</i> , either manually or automatically initiated, which is provided for the restoration or control of the <i>power system frequency</i> by <i>Western Power</i> to cater for <i>contingency events</i> or shortages of <i>supply</i> .
intra-regional	Within a <i>region</i> .
inverter coupled generating unit	A generator which uses a machine, device, or system that changes its direct-current power to alternating-current power acceptable for power system connection.
large disturbance	The disturbance is considered to be sufficiently large or severe if linearization of system equations is not permissible for the purposes of analysis. The resulting system response involves large excursions of system variables from their pre-disturbance values, and is influenced by non-linear power-angle relationship and other non-linearity effects in power systems. Large disturbance is typically caused by a short circuit on a nearby power system component (for example, transmission line, transformer, etc).
load	A <i>connection point</i> at which electrical power is delivered to a person or the amount of electrical power delivered at a defined instant at a <i>connection point</i> .
load centre	A geographically concentrated area containing <i>load</i> or <i>loads</i> with a significant combined consumption capability.
load shedding	Reducing or disconnecting <i>load</i> from the <i>power system</i> .

TECHNICAL CODE
ATTACHMENT 1 – GLOSSARY

local black system procedures	The procedures, described under clause 5.8.9 applicable to a <i>User</i> as approved by <i>Western Power</i> from time to time.
maximum fault current	The current that will flow to a fault on an item of <i>plant</i> when <i>maximum system conditions</i> prevail.
maximum system conditions	For any particular location in the <i>power system</i> , <i>maximum system conditions</i> as those which will prevail with the maximum number of <i>generators</i> normally connected at times of maximum <i>generation</i> .
minimum fault current	The current that will flow to a fault on an item of <i>plant</i> when present day <i>minimum system conditions</i> prevail.
minimum system conditions	For any particular location in the <i>power system</i> , <i>minimum system conditions</i> as those which will prevail with the least number of <i>generators</i> normally connected at times of minimum <i>generation</i> , in combination with one <i>primary plant outage</i> . The <i>primary plant outage</i> shall be taken to be that which, in combination with the minimum <i>generation</i> , leads to the lowest fault current at the particular location for the fault type under consideration.
monitoring equipment	The testing instruments and devices used to record the performance of <i>plant</i> for comparison with expected performance.
month	Unless otherwise specified, the period of beginning at 12.00 am on the “relevant commencement date” and ending at 12.00 am on the date in the “next calendar month” corresponding to the commencement date of the period. If the “relevant commencement date” is the 29th, 30th or 31st and this date does not exist in the “next calendar month”, then the end date in the “next calendar month” shall be taken as the last day of that month.
nameplate rating	The maximum continuous output or consumption in MW or MVA of an item of equipment as specified by the manufacturer.
NATA	National Association of Testing Authorities.
network	See definition for <i>electricity transmission network</i> .
network capability	The capability of the <i>network</i> or part of the <i>network</i> to transfer electricity from one location to another.
network losses	<i>Energy</i> losses incurred in the transfer of electricity over a <i>transmission network</i> .
network planning criteria	Has the meaning given in the <i>Regulations</i> .
new capacity	Has the meaning given in the Electricity Corporation Act 1994.

TECHNICAL CODE
ATTACHMENT 1 – GLOSSARY

nomenclature standards	The standards approved by <i>Western Power</i> relating to numbering, terminology and abbreviations used for information transfer between <i>Users</i> as provided for in clause 5.12.
non-credible contingency event	A <i>contingency event</i> other than a <i>credible contingency event</i> . It means a <i>contingency event</i> in relation to which, in the circumstances, the probability of occurrence is considered by <i>Western Power</i> to be very low.
non-dispatchable generating unit	A generator that in its satisfactory normal operating state is not capable of controlling its real power output within fine limits.
normal operating frequency band	In relation to the <i>frequency</i> of the <i>power system</i> , means the range specified in clause 5.2.1(a).
normal operating frequency excursion band	In relation to the <i>frequency</i> of the <i>power system</i> , means the range specified as being acceptable for infrequent and momentary excursions of <i>frequency</i> outside the <i>normal operating frequency band</i> being the range specified in clause 5.2.1(a).
operational communication	A communication concerning the arrangements for, or actual operation of the <i>power system</i> in accordance with the <i>Code</i> .
outage	Has the meaning given in the <i>Regulations</i> .
peak load	Maximum <i>load</i> .
plant	Includes all equipment involved in generating, utilising or transmitting electrical <i>energy</i> .
power factor	The ratio of the <i>active power</i> to the apparent power at a point.
power station	In relation to a <i>Generator</i> , a <i>facility</i> in which any of that <i>Generator's</i> <i>generating units</i> are located.
power system	The electricity power system including associated <i>generation</i> and <i>transmission and distribution networks</i> for the <i>supply</i> of electricity, operated as an integrated arrangement.
power system operating procedures	The procedures to be followed by <i>Users</i> in carrying out operations and /or maintenance activities on or in relation to primary and <i>secondary equipment connected</i> to or forming part of the <i>power system</i> or <i>connection points</i> , as described in clause 5.10.1.
power system reliability	<i>Reliability</i> of a power system refers to the probability of its satisfactory operation over the long run. It denotes the ability to supply adequate electric service on a nearly continuous basis, with few interruptions over an extended time period.

TECHNICAL CODE
ATTACHMENT 1 – GLOSSARY

power system security	<i>Security</i> of a power system refers to the degree of risk in its ability to survive imminent disturbances (contingencies) without interruption of customer service. It relates to robustness of the system to imminent disturbances and, hence, depends on the system operating condition as well as the contingent probability of disturbances.
power system stability	<i>Power system stability</i> is the ability of an electric power system, for a given initial operating condition, to regain a state of operating equilibrium after being subjected to a physical disturbance, with most system variables bounded so that practically the entire system remains intact.
power transfer	The instantaneous rate at which <i>active energy</i> is transferred between <i>connection points</i> .
power transfer capability	The maximum permitted <i>power transfer</i> through a <i>transmission network</i> or part thereof.
primary plant	Refers to apparatus which conducts <i>power system load</i> or conveys <i>power system voltage</i> .
protection	Used to describe the concept of detecting, limiting and removing the effects of <i>primary plant</i> faults from the <i>power system</i> . Also used to refer to the apparatus required to achieve this function.
protection apparatus	Includes all relays, <i>meters</i> , power circuit breakers, synchronisers and other control devices necessary for the proper and safe operation of the <i>power system</i> .
protection scheme	A collection of one or more sets of <i>protection</i> for the purpose of protecting <i>facilities</i> and the <i>electricity transmission network</i> from damage due to an electrical or mechanical fault or due to certain conditions of the <i>power system</i> .
protection system	A system which includes all the <i>protection schemes</i> applied to the system.
quality of supply	Has the meaning, with respect to electricity, technical attributes to a standard referred to in clause 2.2, unless otherwise stated in this <i>Code</i> or an <i>access agreement</i> .
ramp rate	The rate of <i>change</i> of electricity produced from a <i>generating unit</i> .
reactive energy	A measure, in varhours (VARh) of the alternating exchange of stored energy in inductors and capacitors, which is the time-integral of the product of <i>voltage</i> and the out-of-phase component of current flow across a <i>connection point</i> .

TECHNICAL CODE
ATTACHMENT 1 – GLOSSARY

reactive plant	<i>Plant</i> which is normally specifically provided to be capable of providing or absorbing <i>reactive power</i> and includes the <i>plant</i> identified in clause 5.5.1(g).
reactive power	The rate at which <i>reactive energy</i> is transferred. <i>Reactive power</i> is a necessary component of alternating current electricity which is separate from <i>active power</i> and is predominantly consumed in the creation of magnetic fields in motors and <i>transformers</i> and produced by <i>plant</i> such as: (a) alternating current generators (b) capacitors, including the capacitive effect of parallel <i>transmission wires</i> ; (c) <i>synchronous condensers</i> .
reactive power capability	The maximum rate at which <i>reactive energy</i> may be transferred from a <i>generating unit</i> to a <i>connection point</i> as specified in an <i>access agreement</i> .
reactive power reserve	Unutilised sources of <i>reactive power</i> arranged to be available to cater for the possibility of the unavailability of another source of <i>reactive power</i> or increased requirements for <i>reactive power</i> .
reactive power support/reactive support	The provision of <i>reactive power</i> .
reactor	A device, similar to a <i>transformer</i> . Arranged to be <i>connected</i> into the <i>transmission network</i> during periods of low <i>load</i> demand or low <i>reactive power</i> demand to counteract the natural capacitive effects of long <i>transmission lines</i> in generating excess <i>reactive power</i> and so correct any <i>transmission voltage</i> effects during these periods.
region, regional	An area determined by <i>Western Power</i> , being an area served by a particular part of the <i>transmission network</i> containing one or more major <i>load centres</i> or <i>generation centres</i> or both.
regulating duty	In relation to a <i>generating unit</i> , the duty to have its generated output adjusted frequently so that any <i>power system frequency</i> variations can be corrected.
Regulations	Means the Electricity Transmission Regulations 1996.
reliability	The probability of a system, device, <i>plant</i> or equipment performing its function adequately for the period of <i>time</i> 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.

TECHNICAL CODE
ATTACHMENT 1 – GLOSSARY

remote back up protection	Refers to the detection and initiation of tripping at a location other than that at which the main <i>protection scheme</i> of the faulted <i>plant</i> is located. <i>Remote back up protection</i> provides a means of detecting and initiating clearance of <i>small zone faults</i> or fault contributions supplied via failed circuit breakers.
remote monitoring equipment (RME)	Equipment installed to enable monitoring of a <i>facility</i> from a <i>control centre</i> , including a remote terminal unit (RTU).
representative	In relation to a person, any employee, agent or <i>Consultant</i> of: (a) that person; or (b) a <i>related body corporate</i> of that person; or (c) a third party contractor to that person.
reserve	The <i>active power</i> and <i>reactive power</i> available to the <i>power system</i> at a nominated <i>time</i> but not currently utilised.
RTU	Has the meaning given in the <i>Regulations</i> .
satisfactory operating state	In relation to the <i>power system</i> , has the meaning given in clause 5.2.1.
SCADA system	Supervisory control and data acquisition equipment which enables <i>Western Power</i> to continuously and remotely monitor, and to a limited extent control, the import or export of electricity from or to the <i>power system</i> .
scheduled generating unit	A <i>generating unit</i> which is dispatched by <i>Western Power</i> .
secondary equipment, secondary plant	Those assets of a <i>facility</i> and the <i>electricity transmission network</i> which do not carry the <i>energy</i> being traded, but which are required for control, protection or operation of assets which carry such <i>energy</i> .
secondary plant contingency	Any single failure of <i>secondary plant</i> .
secure operating state	In relation to the <i>power system</i> has the meaning given in clause 5.2.2.
sensitivity	In relation to <i>protection schemes</i> , has the meaning in clause 3.4.2.6 for normal operating zones and the meaning in clause 3.4.2.9 for back up operating zones.
settlements	The activity of producing bills and credit notes for <i>Users</i> .
shunt capacitor	A type of <i>plant connected</i> to a <i>network</i> to generate <i>reactive power</i> .
shunt reactor	A type of <i>plant connected</i> to a <i>network</i> to absorb <i>reactive power</i> .

TECHNICAL CODE
ATTACHMENT 1 – GLOSSARY

single contingency	In respect of a <i>transmission network</i> , a sequence of related events which result in the removal from service of one <i>transmission line</i> , <i>transformer</i> or other item of <i>plant</i> . The sequence of events may include the application and clearance of a fault of defined severity.
single credible contingency event	An individual <i>credible contingency event</i> for which a <i>User</i> adversely affected by the event would reasonably expect, under normal conditions, the design or operation of the relevant part of the meshed <i>power system</i> would adequately cater, so as to avoid significant disruption to <i>power system security</i> .
small disturbance	The disturbance is considered to be sufficiently small if linearization of system equations is permissible for the purposes of analysis. The resulting system response involves small excursions of system variables from their pre-disturbance values. Small disturbances may be caused by routine switching (for example, line or capacitor), transformer tap changes, generator AVR setpoint changes, etc.
small zone fault	A fault which occurs on an area of <i>plant</i> that is within the zone of detection of a <i>protection scheme</i> , but for which not all contributions will be cleared by the circuit breaker(s) tripped by that <i>protection scheme</i> . For example, a fault in the area of <i>plant</i> between a <i>current transformer</i> and a circuit breaker, fed from the <i>current transformer</i> side, may be a <i>small zone fault</i> .
South West Interconnected System	The <i>network</i> in South West of the state of Western Australia, extending from Geraldton to Albany areas and across to the Eastern Goldfields.
spare capacity	Has the meaning given in the Electricity Corporation Act 1994.
standby power	Has the meaning given in the Electricity Corporation Act 1994.
static excitation system	An <i>excitation control system</i> in which the power to the rotor of a synchronous <i>generating unit</i> is transmitted through high power solid-state electronic devices.
static VAR compensator	A device specifically provided on a <i>network</i> to provide the ability to generate and absorb <i>reactive power</i> and to respond automatically and rapidly to <i>voltage</i> fluctuations or <i>voltage</i> instability arising from a disturbance or disruption on the <i>transmission network</i> .
substation	A <i>facility</i> at which lines are switched for operational purposes. May include one or more <i>transformers</i> so that some <i>connected</i> lines operate at different nominal <i>voltages</i> to others.
supply	The delivery of electricity.
synchronise	The act of <i>synchronising</i> a <i>generating unit</i> to the <i>power system</i> .

TECHNICAL CODE
ATTACHMENT 1 – GLOSSARY

synchronising, synchronisation	To electrically <i>connect</i> a <i>generating unit</i> to the <i>power system</i> .
synchronous condensers	<i>Plant</i> , similar in construction to a <i>generating unit</i> of the <i>synchronous generator</i> category, which operates at the equivalent speed of the <i>frequency</i> of the <i>power system</i> , specifically provided to generate or absorb <i>reactive power</i> through the adjustment of rotor current.
synchronous generator voltage control	The automatic <i>voltage control system</i> of a <i>generating unit</i> of the <i>synchronous generator</i> category which changes the output <i>voltage</i> of the <i>generating unit</i> through the adjustment of the generator rotor current and effectively changes the <i>reactive power</i> output from that <i>generating unit</i> .
synchronous generator, synchronous generating unit	The alternating current generators which operate at the equivalent speed of the <i>frequency</i> of the <i>power system</i> in its <i>satisfactory operating state</i> .
tap-changing transformer	A <i>transformer</i> with the capability to allow internal adjustment of output <i>voltages</i> which can be automatically or manually initiated while on-line and which is used as a major component in the control of the <i>voltage</i> of the <i>transmission networks</i> in conjunction with the operation of <i>reactive plant</i> . The <i>connection point</i> of a <i>generating unit</i> may have an associated tap-changing transformer, usually provided by the <i>Generator</i> .
tariff meter	A device complying with <i>Australian Standards</i> which measures and records the production or consumption of electrical energy that is used for obtaining the primary source of <i>tariff metering data</i> .
tariff metering	Recording the production or consumption of electrical <i>energy</i> .
tariff metering data	The data obtained from a <i>tariff metering installation</i> , the processed data or substituted data.
tariff metering database	A database of <i>tariff metering data</i> .
tariff metering installation	The assembly of components between the <i>tariff metering point(s)</i> and the point of connection to the public switched telephone network used as the primary source of <i>tariff metering data</i> for the <i>settlements</i> process. This may include the combination of several <i>tariff metering points</i> to derive the <i>tariff metering data</i> for a <i>connection point</i> .
tariff metering point	The point of physical <i>connection</i> of the device measuring the current in the power conductor.
tariff metering register	A register of information associated with a <i>tariff metering installation</i> as required by clause 6.4.
tariff metering specifications	Specifications prepared by <i>Western Power</i> for equipment including <i>tariff meter</i> and communications enclosures, indoor and outdoor <i>tariff metering</i> units (<i>VTs</i> and <i>CTs</i> plus enclosure), <i>CTs</i> , <i>VTs</i> , marshalling box and wiring.

TECHNICAL CODE
ATTACHMENT 1 – GLOSSARY

tariff metering system	The collection of all components and arrangements installed or existing between each <i>tariff metering point</i> and the <i>tariff metering database</i> .
technical envelope	The limits described in clause 5.2.3.
teleprotection signalling	Equipment used to transfer a contact state from one location to another using communications equipment. The equipment used for this purpose will meet the <i>reliability</i> and quality requirements of <i>protection</i> equipment.
thermal generating unit	A generating unit which uses fuel combustion for electricity generation.
time	Western Standard Time, being the time at the 120 th meridian of longitude east of Greenwich in England, or Co-ordinated Universal Time, as required by the National Measurement Act, 1960.
total fault clearance time	Refers to the time from fault inception to the time of complete fault interruption by a circuit breaker or circuit breakers. This is to be taken, as a minimum, to be equal to 10ms plus the circuit breaker maximum break time plus the maximum protection operating time.
transformer	A <i>plant</i> or device that reduces or increases the <i>voltage</i> of alternating current.
transformer tap position	Where a tap changer is fitted to a <i>transformer</i> , each tap position represents a <i>change</i> in <i>voltage</i> ratio of the <i>transformer</i> which can be manually or automatically adjusted to change the <i>transformer</i> output <i>voltage</i> . The tap position is used as a reference for the output <i>voltage</i> of the <i>transformer</i> .
transmission	Activities pertaining to a <i>transmission network</i> including the conveyance of electricity.
transmission element	A single identifiable major component of a <i>transmission network</i> involving: (a) an individual <i>transmission</i> circuit or a phase of that circuit; (b) a major item of <i>transmission plant</i> necessary for the functioning of a particular <i>transmission</i> circuit or <i>connection point</i> (such as a <i>transformer</i> or a circuit breaker).
transmission line	A power line that is part of a <i>transmission network</i> .
transmission network	See definition for <i>electricity transmission network</i> .
transmission network connection point	A <i>connection point</i> on a <i>transmission network</i> .
transmission network test	Test conducted to verify the magnitude of the <i>power transfer capability</i> of the <i>transmission network</i> or investigating <i>power system</i> performance in accordance with clause 4.1.7.

TECHNICAL CODE
ATTACHMENT 1 – GLOSSARY

transmission plant	Apparatus or equipment associated with the function or operation of a <i>transmission line</i> or an associated <i>substation</i> , which may include <i>transformers</i> , circuit breakers, <i>reactive plant</i> and <i>monitoring equipment</i> and control equipment.
trip circuit supervision	A function incorporated within a <i>protection</i> that results in alarming for loss of integrity of the <i>protection's</i> trip circuit. <i>Trip circuit supervision</i> supervises a <i>protection's</i> trip supply together with the integrity of associated wiring, cabling and circuit breaker trip coil.
trip supply supervision	A function incorporated within a <i>protection</i> that results in alarming for loss of trip supply.
Turbine control system	The automatic <i>control system</i> which regulates the speed and power output of a <i>generating unit</i> through the control of the rate of entry into the <i>generating unit</i> of the primary <i>energy</i> input (for example, steam, gas or water). Old terminology is <i>governor system</i> .
two fully independent protections of differing principle	Where an item of <i>plant</i> is required to be protected by <i>two fully independent protections of differing principle</i> , such <i>protections</i> shall, in combination, provide dependable clearance of faults on that <i>plant</i> within a specified time, with any single failure to operate of the <i>secondary plant</i> . To achieve this, complete <i>secondary plant</i> redundancy is required including, but not necessarily limited to, <i>current transformer</i> and <i>voltage transformer</i> secondaries, auxiliary supplies, signalling systems, cabling, wiring, and circuit breaker trip coils. Auxiliary supplies include DC supplies for <i>protection</i> purposes. Therefore, to satisfy the redundancy requirements, each fully independent <i>protection</i> would need to have its own independent battery and battery charger system supplying all that <i>protection's</i> trip functions. The <i>protections</i> shall be so chosen as to have <i>differing principles</i> of operation.
unit protection	Generally, a <i>protection scheme</i> that compares the conditions at defined <i>primary plant</i> boundaries and can positively identify whether a fault is internal or external to the protected <i>plant</i> . <i>Unit protection schemes</i> can provide high speed (less than 150 milliseconds) <i>protection</i> for the protected <i>primary plant</i> . Generally, <i>unit protection schemes</i> will not be capable of providing <i>back up protection</i> .
user	Has the meaning given in the Electricity Corporation Act 1994.
voltage	The electronic force or electric potential between two points that gives rise to the flow of electricity.
voltage transformer (VT)	A <i>transformer</i> for use with <i>meters</i> and/or protection devices in which the <i>voltage</i> across the secondary terminals is, within prescribed error limits, proportional to and in phase with the <i>voltage</i> across the primary terminals.
Western Power	Has the meaning given in the <i>Regulations</i> , but modified in accordance with clause 1.2 of this <i>Code</i> .

TECHNICAL CODE
ATTACHMENT 1 – GLOSSARY

Western Power power system security responsibilities	The responsibilities described in clause 5.3.1.
---	---

ATTACHMENT 2

RULES OF INTERPRETATION

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

- (a) a reference in this *Code* to a contract or another instrument includes a reference to any amendment, variation or replacement of it;
- (b) a reference to a person includes a reference to the person's executors, administrators, successors, substitutes (including, without limitation, persons taking by novation) and assigns;
- (c) if an event must occur on a *day* which is not a *business day* then the event must occur on the next *business day*;
- (d) any calculation shall be performed to the accuracy, in terms of a number of decimal places, determined by *Western Power* in respect of all *Users*;
- (e) if examples of a particular kind of conduct, thing or condition are introduced by the word “**including**”, then the examples are not to be taken as limiting the interpretation of that kind of conduct, thing or condition;
- (f) a *connection* is a *User's connection* or a *connection* of a *User* if it is the subject of an *access agreement* between the *User* and *Western Power*; and
- (g) a reference to a half hour is a reference to a 30 minute period ending on the hour or on the half hour and, when identified by a time, means the 30 minute period ending at that time.

ATTACHMENT 3

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

- A3.1. Various sections of the *Code* require that *Users* submit technical data to *Western Power*. This attachment summarises schedules which list the typical range of data which may be required and explains the terminology. Data additional to those listed in the schedules may be required. The actual data required will be advised by *Western Power* at the time of assessment of a *transmission access application*, and will form part of the technical specification in the *access agreement*.
- A3.2. Data is coded in categories, according to the stage at which it is available in the build-up of data during the process of forming a *connection* or obtaining access to a *network*, with data acquired at each stage being carried forward, or enhanced in subsequent stages, eg. by testing.
- Preliminary system planning data**
This is data required for submission with the *access application*, to allow *Western Power* to prepare an offer of terms for an *access agreement* and to assess the requirement for, and effect of, *network augmentation* or *extension* options. Such data is normally limited to the items denoted as Standard Planning Data (S) in the technical data schedules S1 to S5. *Western Power* may, in cases where there is reasonable doubt as to the viability of a proposal, require the submission of other data before making an access offer to *connect* or to amend an *access agreement*.
- Registered system planning data**
This is the class of data which will be included in the *access agreement* signed by both parties. It consists of the preliminary system planning data plus those items denoted in the attached schedules as Detailed Planning Data (D). The latter must be submitted by the *User* in time for inclusion in the *access agreement*.
- Registered data**
Registered Data consists of data validated and *augmented* prior to actual *connection* a provision of access from manufacturers' data, detailed design calculations, works or site tests etc. (R1); and data derived from on-system testing after *connection* (R2).
All of the data will, from this stage, be categorised and referred to as Registered Data; but for convenience the schedules omit placing a higher ranked code next to items which are expected to already be valid at an earlier stage.
- A3.3. Data will be subject to review at reasonable intervals to ensure its continued accuracy and relevance. *Western Power* must initiate this review. A *User* may *change* any data item at a time other than when that item would normally be reviewed or updated by submission to *Western Power* of the revised data, together with authentication documents, eg. test reports.
- A3.4. Schedules S1 to S5, which are given in the respective Attachments 4 to 8, cover the following data areas:
- (a) Schedule S1 - *Generating Unit Design Data*. This comprises *generating unit* fixed design parameters.
 - (b) Schedule S2 - *Generating Unit Setting Data*. This comprises settings which can

- be varied by agreement or by *direction* of *Western Power*.
- (c) Schedule S3 - *Transmission Network* and *Plant* Technical Data. This comprises fixed electrical parameters.
 - (d) Schedule S4 - *Transmission Plant* and Apparatus Setting Data. This comprises settings which can be varied by agreement or by *direction* of *Western Power*.
 - (e) Schedule S5 - *Load* Characteristics. This comprises the estimated parameters of *load* groups in respect of, for example, harmonic content and response to *frequency* and *voltage* variations.
- A3.5. A *Generator* that *connects* a *generating unit*, that is not a *synchronous generating unit*, must be given exemption from complying with those parts of schedules S1 and S2 that are determined by *Western Power* to be not relevant to such *generating units*, but must comply with those parts of Schedules S3, S4, and S5 that are relevant to such *generating units*, as determined by *Western Power*. For this non-synchronous generating unit, additional data may be requested by *Western Power*.

Codes:

S = Standard Planning Data

D = Detailed Planning Data

R = Registered Data (R1 pre-connection, R2 post-connection)

ATTACHMENT 4

SCHEDULE S1 - GENERATING UNIT DESIGN DATA

Symbol	Data Description	Units	Data Category
Power Station Technical Data:			
	<i>Connection Point to Network</i>	Text, diagram	S, D
	Nominal <i>voltage</i> at <i>connection to Network</i>	kV	S
	Total Station Net Maximum Capacity (NMC)	MW (<i>sent out</i>)	S, D, R2
At Connection Point:			
	Maximum 3 phase short circuit infeed calculated by method of AS 3851 (1991)		
	· Symmetrical	kA	S, D
	· Assymetrical	kA	D
	Minimum zero sequence impedance	(a+jb)% on 100 MVA base	D
	Minimum negative sequence impedance	(a+jb)% on 100 MVA base	D
Individual Synchronous Generating Unit Data:			
	Make		
	Model		
MBASE	Rated MVA	MVA	S, D, R1
PSO	Rated MW (<i>Sent Out</i>)	MW (<i>sent out</i>)	S, D, R1
PMAX	Rated MW (<i>Generated</i>)	MW (Gen)	D
VT	Nominal Terminal <i>Voltage</i>	kV	D, R1
PAUX	Auxiliary <i>load</i> at PMAX	MW	S, D, R2
Qmax	Rated Reactive Output at PMAX	MVAr (<i>sent out</i>)	S, D, R1
PMIN	<i>Minimum Load (ML)</i>	MW (<i>sent out</i>)	S, D, R2
H	Turbine plus Generator Inertia Constant for all rotating masses connected to the generator shaft (for example, generator, turbine, etc)	MWs/rated MVA	S, D, R1
Hg	<i>Generator</i> Inertia Constant (applicable to <i>synchronous condenser</i> mode of operation)	MWs/rated MVA	S, D, R1
GSCR	Short Circuit Ratio		D, R1
ISTATOR	Rated Stator Current	A	D, R1
IROTOR	Rated Rotor Current at rated MVA and <i>Power Factor</i> , rated terminal volts and rated speed	A	D,R1
VROTOR	Rotor <i>Voltage</i> at which IROTOR is achieved	V	D, R1
VCEIL	Rotor <i>Voltage</i> capable of being <i>supplied</i> for five seconds at rated speed during field forcing	V	D, R1
ZN	Neutral Earthing Impedance	(a+jb)% on MVA base	
Generating Unit Resistance:			
RA	Stator Resistance	% on MBASE	S, D, R1, R2
RF	Rotor resistance at 20°C	ohms	D, R1

Generating Unit Sequence Impedances (saturated):

Z0	Zero Sequence Impedance	(a+jb)% on MBASE	D,R1
Z2	Negative Sequence Impedance	(a+jb)% on MBASE	D,R1

Generating Unit Reactances (saturated):

XD'(sat)	Direct Axis Transient Reactance	% on MBASE	D,R1
XD''(sat)	Direct Axis Sub-Transient Reactance	% on MBASE	D,R1

Generating Unit Reactances (unsaturated):

XD	Direct Axis Synchronous Reactance	% on MBASE	S, D, R1, R2
XD'	Direct Axis Transient Reactance	% on MBASE	S, D, R1, R2
XD''	Direct Axis Sub-Transient Reactance	% on MBASE	S, D, R1, R2

Symbol	Data Description	Units	Data Category
XQ	Quadrature Axis Synch Reactance	% on MBASE	D, R1, R2
XQ'	Quadrature Axis Transient Reactance	% on MBASE	D, R1, R2
XQ''	Quadrature Axis Sub-Transient Reactance	% on MBASE	D,R1, R2
XL	Stator Leakage Reactance	% on MBASE	D, R1, R2
XO	Zero Sequence Reactance	% on MBASE	D, R1
X2	Negative Sequence Reactance	% on MBASE	D, R1
XP	Potier Reactance	% on MBASE	D, R1
Generating Unit Time Constants (unsaturated):			
TDO'	Direct Axis Open Circuit Transient	Seconds	S, D, R1, R2
TDO''	Direct Axis Open Circuit Sub-Transient	Seconds	S, D, R1, R2
TKD	Direct Axis Damper Leakage	Seconds	D, R1, R2
TQO'	Quadrature Axis Open Circuit Transient	Seconds	D, R1, R2
TA	Armature Time Constant	Seconds	D, R1, R2
TQO''	Quadrature Axis Open Circuit Sub-Transient	Seconds	D, R1, R2
Charts:			
GCD	Capability Chart	Graphical data	D, R1, R2
GOCC	Open Circuit Characteristic	Graphical data	R1
GSCC	Short Circuit Characteristic	Graphical data	R1
GZPC	Zero power factor curve V curves	Graphical data	R1
GOTC	MW, MVA 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

GTZOn	Zero Sequence Impedances (each wdg)	(a + jb) % on 100 MVA base	S, D, R1
	Tapped Winding	Text, diagram	S, D, R1
GTAPR	Tap Change Range	kV - kV	S, D
GTAPS	Tap Change Step Size	%	D
	Tap Changer Type, On/Off load	On/Off	D
	Tap Change Cycle Time	Seconds	D
GTVG	Vector Group	Diagram	S, D
	Earthing Arrangement	Text, diagram	S, D
	Saturation curve	Diagram	R1
Generating Unit Reactive Capability (At machine terminals):			
	Lagging <i>Reactive Power</i> at PMAX	MVAr export	S, D, R2
	Lagging <i>Reactive Power</i> at ML	MVAr export	S, D, R2
	Lagging <i>Reactive Short Time capability</i> at rated MW, terminal <i>voltage</i> and speed	MVAr (for time)	D, R1, R2
	Leading <i>Reactive Power</i> at rated MW	MVAr import	S,D, R2

Symbol	Data Description	Units	Data Category
--------	------------------	-------	---------------

Generating Unit Excitation System:

Make			
Model			
General description of <i>excitation control system</i> (including functional block diagram transfer function & parameters)	Text, diagram		S, D
Rated <i>Field Voltage</i> at rated MVA and <i>Power Factor</i> and rated terminal volts and speed	V		S, D, R1
Maximum <i>Field Voltage</i>	V		S, D, R1
Minimum <i>Field Voltage</i>	V		D, R1
Maximum rate of change of <i>Field Voltage</i>	Rising V/s		D, R1
Maximum rate of change of <i>Field Voltage</i>	Falling V/s		D, R1
Generating Unit and exciter Saturation Characteristics 50 - 120% V	Diagram		D, R1
Dynamic Characteristics of Over <i>Excitation</i> Limiter (drawn on capability generator diagram)	Text/ Block diagram		D, R2
Dynamic Characteristics of Under <i>Excitation</i> Limiter (drawn on capability generator diagram)	Text/ Block diagram		D, R2

Generating Unit Turbine / Load Controller (Governor):

Make			
Model			
General description of turbine <i>control system</i> (including block diagram transfer function & parameters)	Text, diagram		S, D
Maximum Droop	%		S, D, R1
Normal Droop	%		D, R1
Minimum Droop	%		D, R1



Maximum <i>Frequency</i> Dead band	Hz	D, R1
Normal <i>Frequency</i> Deadband	Hz	D, R1
Minimum <i>Frequency</i> Deadband	Hz	D, R1
MW Deadband	MW	D, R1
Generating Unit Response Capability:		
Sustained response to <i>frequency</i> change	MW/Hz	D, R2
Non-sustained response to <i>frequency</i> change	MW/Hz	D, R2
<i>Load</i> Rejection Capability	MW	S, D, R2

**Mechanical Shaft Model:
(Multiple-Stage Steam Turbine Generators only)**

Dynamic model of turbine/ <i>Generator</i> shaft system in lumped element form showing component inertias, damping and shaft stiffness.	Diagram	D
Natural damping of shaft torsional oscillation modes.(for each mode)		
- Modal <i>frequency</i>	Hz	D
- Logarithmic decrement	Nepers/Sec	D
Steam Turbine Data: (Multiple-Stage Steam Turbines only) Fraction of power produced by each stage:		

Symbol	Data Description	Units	Data Category
	Symbols KHP KIP KLP1 KLP2	Per unit of Pmax	D
	Stage and Reheat Time Constants:		
	Symbols THP TRH TIP TLP1 TLP2	Seconds	D
	Turbine frequency tolerance curve	Diagram	S, D, R1
	Gas Turbine Data:		
HRSG	Waste heat recovery boiler time constant (where applicable eg for cogeneration plant)	Seconds	D
	MW output versus turbine speed (47-52 Hz)	Diagram	D, R1, R2
	Type of turbine (heavy industrial, aero derivative etc)	Text	S
	Number of shafts		S,D

Gearbox Ratio		D
Fuel type (gas, liquid)	Text	S,D
Base load MW vs temperature	Diagram	D
Peak Load MW vs temperature	Diagram	D
Rated exhaust temperature	°C	S,D
Controlled exhaust temperature	°C	S,D,R1
Turbine frequency tolerance capability	Diagram	D
Turbine compressor surge map	Diagram	D

Hydraulic Turbine Data

Required data will be advised by Western Power

Windfarm/Wind Turbine Data¹⁾

A typical 24 hour power curve measured at 15-minute intervals or better if available;		S, D, R1
maximum kVA output over a 60 second interval		S, D,R1
Long-term flicker factor for generator		S, D, R1
Long term flicker factor for windfarm		S,D,R1
Maximum output over a 60 second interval	kVA	S,D,R1
Harmonics current spectra	A	S,D,R1
Power curve MW vs windspeed	Diagram	D
Spatial Arrangement of windfarm	Diagram	D
Startup profile MW, MVA _r vs time for individual Wind Turbine Unit and Wind Farm Total	Diagram	D
Low Wind Shutdown profile MW, MVA _r vs time for individual Wind Turbine Unit and Wind Farm Total	Diagram	D
MW, MVA _r vs time profiles for individual Wind Turbine Unit under normal ramp up and ramp down conditions.	Diagram	D
High Wind Shutdown profile MW, MVA _r vs time for individual Wind Turbine Unit and Wind Farm Total	Diagram	D

Symbol	Data Description	Units	Data Category
Induction Generator Data			
General			
	Make		
	Model		
MBASE	Rated MVA	MVA	S,D,R1
PSO	Rated MW (<i>Sent out</i>)	MW	S,D,R1
PMAX	Rated MW (<i>Generated</i>)	MW	D

¹⁾ Measurement of power quality characteristics (including flicker and harmonics) in accordance with IEC 61400-21 shall be provided for all wind turbines proposed for connection to the network. This will require a test report on flicker and harmonics in accordance with IEC61400-21

VT	Nominal Terminal Voltage	kV	S,D,R1
	Synchronous Speed	rpm	S,D,R1
	Rated Speed	rpm	S,D,R1
	Maximum Speed	rpm	S,D,R1
	Rated Frequency	Hz	S,D,R1
Qmax	Reactive consumption at PMAX	MVAr import	S,D,R1
	Curves showing torque, power factor, efficiency, stator current, MW output versus slip (+ and -).	Graphical data	D,R1,R2
	Number of capacitor banks and MVAr size at rated voltage for each capacitor bank (if used).	Text	S
	Control philosophy used for VAR/voltage control.	Text	S
H	Combined inertia constant for all rotating masses connected to the generator shaft (for example, generator, turbine, gearbox, etc) calculated at the synchronous speed	MW-sec/MVA	S,D,R1
	Resistance		
Rs	Stator resistance	% on MBASE	D,R1
	Reactances (saturated)		
X'	Transient reactance	% on MBASE	D,R1
X''	Subtransient reactance	% on MBASE	D,R1
	Reactances (unsaturated)		
X	Sum of magnetising and primary winding leakage reactance.	% on MBASE	D,R1
X'	Transient reactance	% on MBASE	D,R1
X''	Subtransient reactance	% on MBASE	D,R1
Xl	Primary winding leakage reactance	% on MBASE	D,R1
	Time Constants (unsaturated)		
T'	Transient	sec	S,D,R1,R2
T''	Subtransient	sec	S,D,R1,R2
Ta	Armature	sec	S,D,R1,R2
To'	Open circuit transient	sec	S,D,R1,R2
To''	Open circuit subtransient	sec	S,D,R1,R2
	Converter Data		
	Control: network commutated or self commutated		
	Additional data may be required by Western Power		
	Doubly Fed Induction Generator Data		
	Required data will be advised by Western Power		

ATTACHMENT 5

SCHEDULE S2 - GENERATING UNIT SETTING DATA

Description Category	Units	Data
Protection Data:		
Settings of the following protections:		
Loss of field	Text	D
Under <i>excitation</i>	Text, diagram	D
Over <i>excitation</i>	Text, diagram	D
Differential	Text	D
Under <i>frequency</i>	Text	D
Over <i>frequency</i>	Text	D
Negative sequence component	Text	D
Stator overvoltage	Text	D
Stator overcurrent	Text	D
Rotor overcurrent	Text	D
Reverse power	Text	D

Control Data:

Details of *excitation control system* incorporating, where applicable, individual elements for power system stabiliser, under excitation limiter and over excitation limiter described in block diagram form showing transfer functions of individual elements, parameters and measurement units (preferably in IEEE format, but suitable for use in the software package nominated by Western Power. Currently, that package is PSS/E): The source code of the model shall also be provided, as per clause 3.2.10.

Text, diagram D,R1,R2

Settings of the following controls:

Details of the turbine control *system* described in block diagram form showing transfer functions of individual elements and measurement units (preferably in IEEE format, but suitable for use in the software package nominated by Western Power. Currently, that package is PSS/E). The source code of the model shall also be provided, as per clause 3.2.10.

	Text, diagram	D,R1,R2
Stator current limiter (if fitted)	Text, diagram	D
Manual restrictive limiter (if fitted)	Text	D
Load drop compensation/VAr sharing (if fitted)	Text, function	D
V/f limiter (if fitted)	Text, diagram	D

ATTACHMENT 6

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

Description	Units	Data Category
Voltage Rating		
Nominal <i>voltage</i>	kV	S, D
Highest <i>voltage</i>	kV	D
Insulation Co-ordination		
Rated lightning impulse withstand <i>voltage</i>	kVp	D
Rated short duration power <i>frequency</i> withstand <i>voltage</i>	kV	D
Rated Currents		
Circuit maximum current	kA	S, D
Rated Short Time Withstand Current	kA for seconds	D
Ambient conditions under which above current applies	Text	S,D
Earthing		
<i>System</i> Earthing Method	Text	S, D
Earth grid rated current	kA for seconds	D
Insulation Pollution Performance		
Minimum total creepage	mm	D
Pollution level	Level of <i>IEC</i> 815	D
Controls		
Remote control and <i>data transmission</i> <i>arrangements</i>	Text	D
Network Configuration		
Operation Diagrams showing the electrical S, D, R1 circuits of the existing and proposed main <i>facilities</i> within the <i>User's</i> ownership including <i>busbar</i> arrangements, phasing arrangements, earthing arrangements, switching <i>facilities</i> and operating <i>voltages</i> .		Single line Diagrams
Network Impedances		
For each item of <i>plant</i> (including lines): R1 details of the positive, negative and zero sequence series and shunt impedances, including mutual coupling between physically adjacent elements.	% on 100 MVA base	S, D,
Short Circuit Infeed to the Network		
Maximum <i>Generator</i> 3-phase short circuit infeed including infeeds from <i>generating units</i> <i>connected</i> to the <i>User's</i> system, calculated by method of AS 3851 (1991).	kA symmetrical	S, D, R1
The total infeed at the instant of fault (including contribution of induction motors).	kA	D, R1

TECHNICAL CODE
ATTACHMENT SIX – SCHEDULE S3 – NETWORK AND PLANT TECHNICAL DATA OF
EQUIPMENT AT OR NEAR CONNECTION POINT

Description	Units	Data Category
Minimum zero sequence impedance of <i>User's network at connection point.</i>	% on 100 MVA base	D, R1
Minimum negative sequence impedance of <i>User's network at connection point.</i>	% on 100 MVA base	D, R1
Load Transfer Capability:		
Where a <i>load</i> , or group of <i>loads</i> , may be fed from alternative <i>connection points</i> :		
<i>Load</i> normally taken from <i>connection point X</i>	MW	D, R1
<i>Load</i> normally taken from <i>connection point Y</i>	MW	D, R1
Arrangements for transfer under planned or fault <i>outage</i> conditions	Text	D
Circuits Connecting Embedded Generating Units to the Network:		
For all <i>generating units</i> , all connecting lines/cables, <i>transformers</i> etc.		
Series Resistance (+ve, -ve & zero seq.)	% on 100 MVA base	D, R
Series Reactance (+ve, -ve & zero seq.)	% on 100 MVA base	D, R
Shunt Susceptance (+ve, -ve & zero seq.)	% on 100 MVA base	D, R
Normal and short-time emergency ratings	MVA	D,R
Technical Details of <i>generating units</i> as per schedules S1, S2		
Transformers at connection points:		
Saturation curve	Diagram	R

ATTACHMENT 7

SCHEDULE S4 - NETWORK PLANT AND APPARATUS SETTING DATA

Description	Units	Data Category
Protection Data for Protection relevant to Connection Point:		
Reach of all <i>protections</i> on <i>transmission lines</i> , or cables	ohms or % on 100 MVA base	S, D
Number of <i>protections</i> on each item	Text	S, D
Total fault clearing times for near and remote faults	ms	S, D, R1
Line reclosure sequence details	Text	S, D, R1
Tap Change Control Data:		
Time delay settings of all <i>transformer</i> tap changers.	Seconds	D, R1
Reactive Compensation (including filter banks):		
Location and Rating of individual <i>shunt reactors</i>	MVA _r	D, R1
Location and Rating of individual <i>shunt capacitor banks</i>	MVA _r	D, R1
<i>Capacitor Bank</i> capacitance	microfarads	D
Inductance of switching reactor (if fitted)	millihenries	D
Resistance of capacitor plus reactor	Ohms	D
Details of special controls (e.g. Point-on-wave switching)	Text	D
For each shunt reactor or capacitor bank (including filter banks):		
Method of switching	Text	S
Details of automatic control logic such that operating characteristics can be determined	Text	D, R1
FACTS Installation:		
Data sufficient to enable static and dynamic performance of the installation to be modelled	Text, diagrams control settings	S, D, R1
Under frequency load shedding scheme:		
Relay settings (frequency and time)	Hz, seconds	S, D
Islanding scheme:		
Triggering signal (e.g. voltage, frequency)	Text	S, D
Relay settings	Control settings	S, D

ATTACHMENT 8

SCHEDULE S5 - LOAD CHARACTERISTICS AT CONNECTION POINT

Data Description	Units	Data Category
For all Types of Load		
Type of <i>Load</i> eg controlled rectifiers or large motor drives	Text	S
Rated capacity	MW, MVA	S
<i>Voltage</i> level	kV	S
Rated current	A	S
For Fluctuating Loads		
Cyclic variation of <i>active power</i> over period	Graph MW/time	S
Cyclic variation of <i>reactive power</i> over period	Graph MVar/time	S
Maximum rate of change of <i>active power</i>	MW/s	S
Maximum rate of change of <i>reactive power</i>	MVar/s	S
Shortest Repetitive time interval between fluctuations in <i>active power</i> and <i>reactive power</i> reviewed annually	s	S
Largest step change in <i>active power</i>	MW	S
Largest step change in <i>reactive power</i>	MVar	S
For commutating power electronic load:		
No. of pulses	Text	S
Maximum <i>voltage</i> notch	%	S
Harmonic current distortion (up to the 50th harmonic)	A or %	S

ATTACHMENT 9

METERING REQUIREMENTS

A9.1 General

- (a) *Tariff metering* equipment, other than *tariff meters* and Communications equipment may be provided and installed by the *User* or will be provided and installed by *Western Power* at the *User's* request. Where tariff metering equipment is installed in Western Power owned substations the equipment will be installed by Western Power.
- (b) Indoor *tariff metering* units provided by *Western Power* will normally be of a type suitable for use with a specific make of switchgear which will vary from time to time.
- (c) *Tariff meters* and the communications equipment other than a connection to the Public Switched Telephone Network (PSTN) will be provided and installed by *Western Power*. The PSTN connection and any isolation required will be provided by the *User*.
- (d) *Tariff metering* equipment will comprise a *tariff metering* unit containing *voltage transformers (VTs)* and *current transformers*, or for system voltages of 66kV and 132kV, free standing post type *VTs* and *CTs* (other than free standing post type *VTs* and *CTs* may be acceptable and each request will be considered), two or more *tariff meters*, cabling, communications equipment, marshalling box and a *tariff meter* enclosure.

A9.2 Installation

- (a) The maximum cable route length between the *CTs* and *VTs* and the *tariff meters* is 80m.
- (b) Marshalling boxes located close to the *CTs* and *VTs* will be required for all indoor-*tariff metering* units and for all outdoor-*tariff metering* units for system voltages of 66kV and 132kV. Indoor-*tariff metering* marshalling boxes will be an integral part of the indoor-*tariff metering* unit.
- (c) Prefabricated free standing or wall mounted *tariff meter* enclosures are available from *Western Power* or a suitable enclosure may be assembled by the *User*. *Tariff meters* may also be located within a building which has provision for unrestricted 24 hour access for *tariff metering* personnel. It may be located adjacent to *Western Power* protection or SCADA equipment. Preference is for a purpose constructed, ventilated, insulated or naturally insulated room of plan dimensions not less than 2m X 2m which substantially maintains ambient air temperature. If *Western Power* is requested to provide a free standing *tariff meter* enclosure and its support frame, the *User* will need to provide a concrete footing as specified in *Western Power's tariff metering specifications*.

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

A9.3 3-4 Wire Metering

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

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

A9.4 Signals

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

A9.5 CCURACY REQUIREMENTS

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

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

NOTE:

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

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

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

c = the error of the *tariff meter*.

A9.6 Other Metering Requirements

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

ATTACHMENT 10

TEST SCHEDULE FOR SPECIFIC PERFORMANCE VERIFICATION AND MODEL VALIDATION

A10.1 General

- (a) Recorders should be calibrated/checked prior to use.
- (b) Recorders should not interact with any *plant* control functions.
- (c) One chart recorder shall be used to provide on site monitoring and rapid evaluation of key quantities during tests even though a digital recorder may be used.

A10.2 Recorder Equipment

Digital Recorder

Signals which are to be digitally recorded and processed require:

- (a) an analogue to digital conversion with at least 12 bit accuracy at full scale.
- (b) a sampling rate of at least 3000 samples per second (ie 3kHz) for up to 20 seconds unless specified otherwise.
- (c) recordings in ASCII format in either a 3½” floppy disc or zip disc readable on IBM or IBM compatible computer.
- (d) departure from linearity of no more than 0.1% in the slope of normalised output versus input. Normalised means value/full range value.
- (e) DC offset errors not greater than 0.05% of full scale in the analogue circuitry.
- (f) 20 - 30 recording channels are required

Chart Recorder

Signals which are to be recorded on charts require:

- (a) a chart speed of at least 20mm/sec
- (b) at least 10 second recording period
- (c) at least 30mm in deviation of quantities
- (d) compliance with (d) & (f) of requirements for Digital Recorder

Tape Recorder

Signals which are to be recorded on Tape require :

- (a) analogue to digital transcription for analogue recordings **or** transcription to multiple chart recordings which are properly annotated.
- (b) production of digital data in ASCII format on either a 3½” floppy disc or zip disc.
- (c) compliance with (d) & (f) of requirements for Digital Recorder.

A10.3 Frequency response

- (a) Where digital or chart recordings of power *frequency* waveforms are to be made a minimum bandwidth of DC - 10kHz is desirable (0dB at DC, -3dB at 10kHz). Suitable filtering is required to eliminate aliasing errors.
- (b) For relatively slowly changing signals (such as main exciter quantities, transducers for MW output etc) a recording device bandwidth of DC - 100Hz is desirable, the minimum acceptable bandwidth being DC - 10Hz.

A10.4 Signal Requirements and Conditioning



- (a) Suitable input signal level should be used and allowance must be made for excursions during transients
- (b) Subtraction of an appropriate amount of floating DC from input signals such as stator *voltage* should be provided so that any perturbations are clearly observable on an on site chart recorder
- (c) Galvanic isolation and filtering of input signals should be provided whenever necessary.

A10.5 Form of Test Results

These shall consist of:

- (a) a brief log showing when tests were done (time, date, test alphanumeric identification).
- (b) chart recordings appropriately annotated.
- (c) relevant schematics of equipment and the local network configuration.
- (d) lists of data collected manually (eg meter readings).
- (e) data in ASCII format.
- (f) SCADA type printout showing the *power system* configuration at the start of, end of, and any other appropriate time during the test sequence.
- (g) other relevant data logger printout (from other than those recorders referred to in Section A10.2).

A10.6 Test Preparation And Presentation of Test Results

Information/data prior to tests

- (a) a detailed schedule of tests agreed by *Western Power*. The schedule should list the tests, when each test is to occur and whose responsibility it will be to perform the test.
- (b) Schematics of equipment and subnetworks plus descriptive material necessary to draw up/agree upon a schedule of tests
- (c) Most up to date relevant technical data and parameter settings of equipment as specified in Attachments 4 to 8 of this *Code*.

Test Notification

- (a) A minimum of 15 Business day prior notice of test commencement should be given to Western power for the purpose of arranging witnessing of tests.
- (b) Western Power's representative should be consulted about proposed test schedules, be kept informed about the current state of the testing program, and give permission to proceed before each test is carried out.
- (c) Unless agreed otherwise, tests should be conducted consecutively.

Test Results

- (a) Test result data must be presented to *Western Power* within 5 *business days* of completion of each test or test series.

- (b) Where test results are not favourable it will be necessary to rectify problem(s) and repeat tests.

A10.7 Quantities to be Measured

- (a) Wherever appropriate and applicable for the tests, the following quantities should be measured on the machine under test:

Generator and Excitation System

- 3 stator L-N terminal *voltages*
- 3 stator terminal currents
- *Active Power* MW
- *Reactive Power* MVAR
- Generator rotor field *voltage*
- Generator rotor field current
- Main exciter field *voltage*
- Main exciter field current
- AVR reference *voltage*
- *Voltage* applied to AVR summing junction (step etc)
- *Power system* stabiliser output
- DC signal input to AVR

Steam Turbine

- Shaft speed
- Load demand signal
- Valve positions for control and interceptor valves
- Turbine control setpoint

Gas turbine

- Shaft speed (engine)
- Shaft speed of turbine driving the generator
- Engine speed control output
- Free turbine speed control output
- Generator-compressor speed control output
- Ambient/turbine air inlet temperature
- Exhaust gas temperature control output
- Exhaust temperature
- Fuel flow
- Turbine control /load reference set point

Hydro

- Shaft speed
- Gate position
- Turbine control /load reference set point

- (a) Western Power will specify test quantities for power plant other than those listed

- above, such as those consisting of wind, solar and fuel cell generators which may also involve AC/DC/AC power conversion or DC/AC power inverters.
- (b) Additional test quantities may be requested and advised by *Western Power* if other special tests are necessary.
- (c) Key quantities such as stator terminal *voltages*, currents, *active power* and *reactive power* of other *generating units* connected on the same bus and also interconnection lines with *Western Power network* (from control room readings) before and after each test must also be provided.

SCHEDULE OF TESTS

TABLE A10.1

TEST DESCRIPTION			
Test No	General Description	Changes Applied	Test Conditions
C1	Step change to AVR voltage reference with the generator on open circuit	(a) +2.5 % (b) -2.5 % (c) +5.0 % (d) -5.0 %	<ul style="list-style-type: none"> • nominal stator terminal volts
C2A	<p><i>Step change to AVR voltage reference with the generator connected to the system.</i></p> <p>(with the Power System Stabiliser out of service)</p> <p>Generator output levels:</p> <p>(i) 50% rated MW, and</p> <p>(ii) 100% rated MW</p>	<p>(a) +1.0 % (b) -1.0 % (c) +2.5 % (d) -2.5 % (e) +5.0 % (f) -5.0 %</p> <p>repeat (e) & (f) twice</p> <p>see note i. below</p>	<ul style="list-style-type: none"> • nominal stator terminal volts • unity or lagging power factor • system base load OR typical conditions at the local plant and typical electrical connection to the transmission system • tests for (i) should precede tests for (ii) • smaller step changes should precede larger step changes
C2B	<i>As for C2A but with the PSS in service</i>	Same as in C2A	Same as in C2A

TECHNICAL CODE
ATTACHMENT 10 – TEST SCHEDULE FOR SPECIFIC PERFORMANCE VERIFICATION AND MODEL
VALIDATION

TEST DESCRIPTION			
Test No	General Description	Changes Applied	Test Conditions
C3A	<p><i>Step change to AVR voltage reference with the generator connected to the system.</i></p> <p>(With PSS out of service)</p> <p>System Conditions :</p> <p>(i) system minimum load with no other generation on the same bus OR relatively weak connection to the transmission system, and</p> <p>(ii) system maximum load and maximum generation on same bus OR relatively strong connection to the transmission system</p>	<p>(a) +5 % (b) –5 % repeat (a) & (b) twice;</p> <p>see note v. below</p>	<ul style="list-style-type: none"> • nominal stator terminal volts • unity or lagging power factor • Generator output at 100% rated MW
C3B	As for C3A but with the PSS in service	Same as in C3A	As for C3A.
C4	<p>Step change of MVA on the transmission system</p> <p>PSS Status :</p> <p>(i) PSS in service, and</p> <p>(ii) PSS out of service</p>	<p>Switching in and out of transmission lines (nominated by Western Power)</p>	<ul style="list-style-type: none"> • nominal stator terminal volts • unity or lagging power factor • system base load OR typical conditions at the local plant and typical electrical connection to the transmission system • generator output at 50% rated MW

TECHNICAL CODE
ATTACHMENT 10 – TEST SCHEDULE FOR SPECIFIC PERFORMANCE VERIFICATION AND MODEL
VALIDATION

TEST DESCRIPTION			
Test No	General Description	Changes Applied	Test Conditions
C5	load rejection (real power)	(a) 25 % rated MW (b) 50 % rated MW (c) 100 % rated MW see notes below	<ul style="list-style-type: none"> • nominal stator terminal volts • unity power factor • smaller amount should precede larger amount of load rejection
C6	steady state over-excitation limiter (OEL) operation	MVAr outputs at OEL setting slow raising of excitation to just bring OEL into operation see notes below	<ul style="list-style-type: none"> • 100% MW output • 75% MW output • 50% MW output • 25% MW output • min.MW output
C7	steady state under-excitation limiter (UEL) operation	MVAr outputs at UEL setting slow lowering of excitation to just bring UEL into operation see notes below	<ul style="list-style-type: none"> • 100% MW output • 75% MW output • 50% MW output • 25% MW output • min. MW output
C8	Manual variation of generator open circuit voltage	Stator terminal volt (Ut) (a) increase from 0.5 pu to 1.1 pu (b) decrease from 1.1pu to 0.5 pu see notes below	<ul style="list-style-type: none"> • 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

Test No	TEST DESCRIPTION		
	General Description	Changes Applied	Test Conditions
C9	MVAr capability at full MW output. System maximum load and maximum generation. Test conducted with as high an ambient temperature as possible.	Generator MW and MVAr output levels set to 100% of rated values and maintained for one hour.	<ul style="list-style-type: none"> • System maximum load and generation • Ambient temperature as high as possible

Notes:

- i. for tests C2A and C2B care must be taken not to excite large or prolonged oscillations in MW etc. Therefore, smaller step changes should always precede larger step changes to avoid such oscillations.
- ii. The Figure 10.1 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 10.1
Application of Step Signal

Unless specified otherwise the “-5%” step method shown in Figure 10.1 is used.

- iii. for test C5, the instantaneous overspeed protection should be set at an agreed level depending on unit capability.
- iv. “system” means “power system”
- v. OR a lower step change, with a larger safety margin, as agreed by Western Power
- vi. tests C1, C6, C7 and C8 need not be witnessed by Western Power

SPECIAL SYSTEM TESTS THAT MAY BE REQUESTED

TABLE A10.2

Test No	TEST DESCRIPTION		
	General Description	Changes Applied	Test Conditions
S1	Load rejection (reactive power)	(a) -30 % rated MVAR (b) +25 % rated MVAR see notes below	<ul style="list-style-type: none"> nominal stator terminal volts 0 or minimum MW output
S2	Load rejection (reactive power)	(a) -30 % rated MVAR see notes below	<ul style="list-style-type: none"> nominal stator terminal volts Excitation on Manual Control
S3	Step change of MVAR on the transmission system	Switching in and out of (a) a transformer (b) a reactor (c) a capacitor	<ul style="list-style-type: none"> parallel transformers on staggered taps others as determined by WPC
S4	Islanding of a <u>subsystem</u> consisting of <u>User's generators plus load</u> with export of power via a link to Western Power's main transmission system.	opening of the link	<ul style="list-style-type: none"> 5-10% of generated MW exported via the link 90-95% of generated MW used by the subsystem's load
S5	AVR/OEL changeover	transformer tap change OR small step to AVR voltage reference	<ul style="list-style-type: none"> initially under AVR control at lagging power factor but close to OEL limit
S6	AVR/UEL changeover	transformer tap change OR small step to AVR voltage reference	<ul style="list-style-type: none"> initially under AVR control at leading power factor but close to UEL limit
S7	Testing of a FACTS device (SVC, TCR, STATCOM, etc)	<ul style="list-style-type: none"> step change to reference value in the summing junction of a control element line switching others as appropriate 	<ul style="list-style-type: none"> MVA initial conditions in lines as determined by WPC
S8	Tripping of an adjacent generator	tripping of generating unit(s)	<ul style="list-style-type: none"> initial generator loading as agreed

S9	Variable frequency injection into the AVR summing junction (with PSS out of service)	0.01-100 rad/sec see notes below	<ul style="list-style-type: none"> as determined by WPC
S10	Step change to governor/load reference	(a) 2.5 % step increase in MW demand signal (b) 2.5 % decrease in MW demand signal (c) equivalent of 0.05Hz subtracted from the governor speed ref. (d) equivalent of 0.1 Hz added to governor speed reference see notes below	<ul style="list-style-type: none"> plant output at 50-85% of rated MW others as agreed with Western Power

Notes:

- i. For tests S1(a) and S2 the VAR absorption should be limited so that field voltage does not go below 50% of its value at rated voltage and at no load (ie rated stator terminal voltage with the generator on open circuit).
- ii. For test S1(b) the VAR load should not allow stator terminal voltage to exceed 8% overvoltage (ie 108% of rated value) as a result of the applied change.
- iii. For test S1 and S2, the instantaneous overvoltage protection should be operative and set at an agreed level greater than or equal to 10% overvoltage.
- iv. For test S2, it may be easier to use AVR control first and then change to manual (provided the change is “bumpless”) before the unit trips.
- v. For test S9, care has to be taken not to excite electromechanical resonances (eg poorly damped MW swings) if the machine is on line.
- vi. For the tests S10 plant characteristics may require the changes be varied from the nominal values given. Larger changes may be considered in order to more accurately determine plant performance.
- vii. For test S5 a positive step is applied of X% from the sub-OEL value. But for test S6 a –Y% step from the sub-UEL value as shown in Figure 10.2 is required.

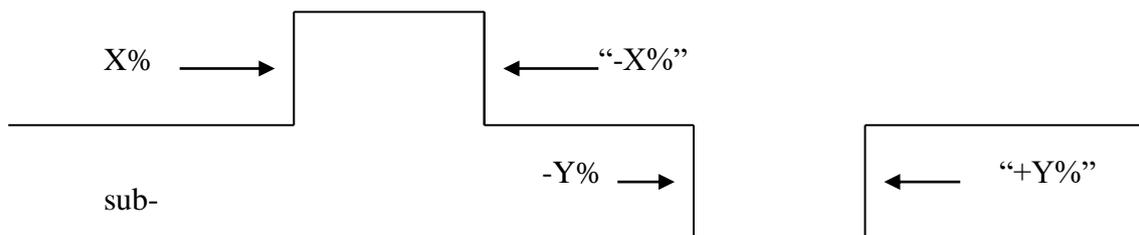


Figure 10.2

This page has been left blank intentionally.

