Review of the Northern Territory Generator Performance Standards

Application to the Utilities Commission to approve amendments to the Network Technical Code and System Control Technical Code

September 2019

PowerWater

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Glossary of terms

Term or abbreviation	Meaning
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ASEFS	AEMO's Australian Solar Energy Forecasting System
Capability	Connection requirement (in the network technical code): Connecting parties are to demonstrate that plant can supply FCAS services if the generator is in the appropriate control mode to do this and with appropriate headroom/floorroom. It does not specify a generator will be obligated to operate in this mode or curtailed to ensure provision.
C-FCAS	Contingency Frequency Control Ancillary Services
Commission	Northern Territory Utilities Commission
Delivery	Operation is the result of provision when a service is used. For instance if a generator tripped, other generators providing C-FCAS raise would then deliver this service by increasing their output in response to the low system frequency.
DKIS	Darwin Katherine Interconnected System
dual fuel	gas/diesel
Electricity Reform Act	*Electricity Reform Act 2000* (NT)
Electricity Reform (Administration) Regulations	*Electricity Reform (Administration) Regulations 2000* (NT)
Enablement	Operational requirement (SCTC): If the System Controller requires a generator to be enabled for FCAS it will only supply it if it has the headroom (for raise) or floorroom (for lower) to do so. A generator operating at maximum output can be enabled for FCAS, but be unable to supply FCAS raise as it has no headroom. In regards to lower service, a generator can provide FCAS lower if it is enabled and it is dispatched above its minimum stable load.
GPS	generator performance standards
insolation	solar irradiance forecast
I-NTEM	Current commercial arrangements in the NT energy market for the Interim Northern Territory Energy Market
Licensee	system controller
MW	megawatts
NEM	National Electricity Market
NER	National Electricity Rules
NT	Northern Territory

NTC	Network Technical Code
NTEM	NT Electricity Market
NTPSPR	Northern Territory Power System Performance Review
NT NER	National Electricity Rules (Northern Territory)
Power and Water or PWC	Power and Water Corporation
Provision	Operational requirement (in the system control technical code): If the System Controller requires a generator to be enabled for FCAS services AND its dispatch level has the headroom or floorroom to supply the FCAS service it is providing FCAS. For example, a generator dispatched below maximum capability that is enabled for FCAS is able to provide an FCAS raise service. This service is the quantity referred to in any market payment arrangements.
RE	renewable energy
R-FCAS	Regulating Contingency Frequency Control Ancillary Services
SCTC	System Control Technical Code
SSG	Secure System Guidelines
TGen	Territory Generation
the Application Act	*National Electricity (Northern Territory) (National Uniform Legislation) Act 2015*
UFLS	under frequency load shedding
UIGF	unconstrained intermittent generation forecast
Utilities Commission Act	*Utilities Commission Act 2000* (NT)
VRE	variable renewable energy
WEM	West Australian Energy Market or Wholesale Electricity Market (WA)

Executive summary

Power and Water performs critical roles in system control and network operation in the Northern Territory (NT), and is responsible for developing various technical instruments that enable statutory objectives to be met, notably the Network Technical Code and System Control Technical Code. However, we require the Commission's approval to change these codes.

The generator performance standards (GPS) are an important pillar of the NT's power system regulatory and coordination framework. They support the interests of Territorian electricity consumers by:

- enabling third party private owners of generation assets to connect those assets to the power system and sell their energy; and
- ensuring the power system remains secure and reliable, and that those who drive risks and costs to the system face those costs, to minimise them commercially.

Doing nothing in relation to GPS for the NT is not an option. The renewable industry is maturing, and increasingly being called on to play a central role in meeting the energy demands of the NT power systems. The NT's extremely small power systems will rapidly move to the point where renewable generators represent the majority of the generation production at certain times. Unless appropriate GPS are implemented as soon as possible, the objectives of both the Utilities Commission Act and Electricity Reform Act will be undermined.

This application follows nine months of formal consultation with stakeholders on the introduction of GPS for the NT, which is described within this application. That consultation has resulted in a number of improvements to our proposed amendments. It has also highlighted some stakeholders' initial misconceptions regarding the NT context, and the suitability of equivalent National Electricity Market (NEM) arrangements.

The solutions proposed in this application and code changes are appropriately tailored to the specific conditions that are found in the NT. They are also solutions that Power and Water believes best meet the statutory objectives.

Structure of this application

This application is structured to document how Power and Water has met the content, procedural and consultation requirements to enable the Commission to approve the proposed code changes that are set out in mark-up in the Appendixes.

Part A | describes changes proposed for the Network Technical Code and System Control Technical Code, explains why, and seeks formal Utilities Commission approval for the proposed changes.

- Section 1 introduces the purpose and regulatory framework for this application
- Section 2 sets out the context for and triggers giving rise to the proposed code amendments
- Section 3 documents the consultation process undertaken by Power and Water that has informed and refined the proposed code amendments
- Section 4 provides an overview of the proposed code amendments

Part B | provides supporting information on key issues raised during consultation on the proposed changes

- Section 5 – application of GPS and grandfathering provisions
- Section 6 – forecasting requirements and consideration of other options
- Section 7 – generator classifications
- Section 8 – inertia and/or C-FCAS capability requirements.

For each of these key issues, Power and Water describes the proposed amendment, the problems the amendment seeks to address, why the proposed amendment is preferable to alternatives considered and raised by stakeholders, and how the proposed amendment meets the requirements that the Commission must consider under section 6(2) of the *Utilities Commission Act*.

Appendix A | Amended Network Technical Code

Appendix B | Amended System Control Technical Code

Appendix C | List of proposed code change provisions

Appendix D | Outcomes of the June-July 2019 round of consultation

Appendix E | Report by Entura confirming positions after consultation

Appendix F | Industry Initiated Code Change Proposals

Part A | Required GPS changes

1. Introduction

1.1 Purpose of this application

This application seeks approval from the Utilities Commission (the Commission) for amendments to the Network Technical Code (NTC) and System Control Technical Code (SCTC) as marked up in Appendix A and Appendix B.

These amendments give effect to the generator performance standards (GPS) that Power and Water Corporation (Power and Water) has been consulting stakeholder on since late 2018.

1.2 Framework for approving code changes

The framework for developing and approving changes to the instruments affected by the GPS is set out in the instruments listed in the table below.

Table 1.1: Powers and processes to amend GPS-related instruments

Instrument	Source of power to amend	By whom? In what capacity?	Process required
Network Technical Code NTC	Regulation 25 of the Electricity Reform (Administration) Regulations 2000 NTC content stipulated in Schedule 2 of those Regs	Power and Water in its capacity as **network provider** The Commission is consulted, and can require amendments to the proposed amendments[1]	Network provider must: publish draft proposed amendments; invite submissions and allow a reasonable time; and consider submissions[2] Network provider must change the proposed amendments if required by the Commission

[1] Regulation 25(5)(b) of the Electricity Reform (Administration) Regulations 2000

[2] Regulation 25(6) of the Electricity Reform (Administration) Regulations 2000.

Instrument	Source of power to amend	By whom? In what capacity?	Process required
System Control Technical Code SCTC	Section 38(1) of the *Electricity Reform Act 2000* - power to make SCTC The content the SCTC may include is set out in regulation 5A, Electricity Reform (Administration) Regulations 2000 Content and power to amend are also set out in Clause 15 of the Power and Water System Control Licence Clause 1.8.2 in the SCTC sets out the amendment process	Power and Water in its capacity as system controller (licensee) subject to approval of Commission as regulator Commission may require amendment to the SCTC	Licensee *may* amend at any time, with the prior written approval of the Commission[3] Licensee *must* amend if requested to do so by the Commission[4] Licensee must consult with all electricity entities holding a generation licence, network licence or retail licence (or current market licence) when establishing and amending the Code[5] Commission must not approve unless satisfied that the system controller has consulted with all electricity entities that are engaged in the operation of, contribute electricity to, or take electricity from, the power system[6] System controller must publish consultation submissions when Code is approved[7]
Secure System Guidelines SSG	Clause 3.5 of the SCTC	Power and Water in its capacity as Power System Controller	Can amend, vary or replace at any time, provided: - Must consult first with System Participants[8] - Must take into account government policy, system controller's statutory obligations, historic levels of reliability, and costs and benefits[9]

2. Drivers for code amendments

The generator performance standards (GPS) are an important pillar of the Norther Territory's (NT) power system regulatory and coordination framework that:

- enables third party private owners of generation assets to connect those assets to the power system and sell their energy; and

[3] Regulation 5A, Electricity Reform (Administration) Regulations 2000; clause 15.3 System Control Licence issued by the Commission to Power and Water; Clause 1.8.2(e) of the SCTC
[4] Clause 15.4, System Control Licence issued by Commission to Power and Water
[5] Clause 15.5, System Control Licence; clause 1.8(f) of the SCTC
[6] Regulation 5A(3) Electricity Reform (Administration) Regulations 2000
[7] Clause 1.8.2(g) of the SCTC
[8] SCTC clause 3.5.3
[9] SCTC clause 3.5.4 (a) to (d)

- ensures the power system remains secure and reliable, and those who drive risks and costs to the system face the costs of doing so that they can commercially minimise these.

Power and Water initiated the formal consultation on the GPS requirements with the publication of the proposed instrument changes in late 2018. Our lengthy consultation in part reflected the fact that our NT context was not well understood by some stakeholders who considered Power and Water should simply adopt the equivalent current National Electricity Market (NEM) arrangements.

This section explains the following matters and where relevant responds to stakeholder submissions on these during the second round of consultation:

- The multiple instruments and functions within Power and Water that are required to give effect to and implement the GPS;
- The NT policy context within which this GPS review is being performed;
- The NT system contexts for the three regulated power systems within which the GPS must perform their intended function;
- The principles and least cost assessment approach that have informed how Power and Water has approached this review, and how these relate to those matters that the Commission is required to consider when reviewing and approving amendments to the instruments that give effect to the GPS; and
- How the above points give rise to a framework for the future that has governed this GPS review.

2.1 Power and Water's system control role

The System Controller's role is to monitor and control operation of the NT's regulated power systems to achieve safety, security, reliability and efficiency of power system operations. In practice this means that all day every day, Power and Water must balance the supply of energy coming into the power system with customers' demand for energy. To do so, Power and Water must keep energy moving through the system and account for any constraints in the power grid (poles and wires) that delivers energy from generators to customers.

In this way the System Controller's job is to 'keep the lights on' by balancing supply and demand for energy in real time. This is often called maintaining power system security, and is equivalent to the role that the Australian Energy Market Operator (AEMO) performs independently in the interconnected NEM and in the West Australian Energy Market (WEM). This System Control role differs from the Network Operator (or grid) part of the Power and Water business who also work to 'keep the lights on' but who do so by building and maintaining the grid assets that deliver energy—see section 2.2.

2.1.1 Relevant system control instruments

Power and Water is licenced by the Commission to perform the functions of the System Controller.[10] As System Controller, Power and Water rely upon the conditions of generator connection[11] to be able

[10] The System Controller's functions are established under section 38 of the Electricity Reform Act.
[11] Which are found in the Network Technical Code.

to manage the power system securely, and are responsible for two key regulatory instruments that allow us to operate generators in accordance with the GPS:

- *System Control Technical Code (SCTC)* | The SCTC sets out operating protocols, arrangements for security and dispatch, arrangements for disconnection, and any other matters relating to monitoring, operation and control of regulated power systems, which the System Controller considers appropriate for the reliable, safe, secure and efficient operation of the power systems. The SCTC is formally approved by the Commission.

- *Secure System Guidelines (SSG)* | The SSG are an instrument of the SCTC that outlines in a public document how System Control seeks to meet the requirements outlined in the SCTC. The SSG set out the principles and details for determining whether the power system is in a secure state. The SSG also contains a section on overarching power system parameters, and participant-specific sections for potentially commercial-in-confidence or ring-fenced information. The participant-specific sections are developed on an as-needs basis. The SSG is developed by Power and Water through a public consultation process, and is issued by Power and Water. Power and Water reports on compliance on the key provisions of the SSG to the Commission.

2.2 Power and Water's network operator role

Power and Water is also licenced by the Commission to operate three regulated electricity networks and a number of non-regulated electricity networks. The licence allows us to perform the functions of the Network Operator in those networks. As Network Operator, Power and Water are responsible for delivering energy from power generators to homes and businesses in a safe and reliable way. Power and Water also connect new generators and energy users to the grid, provide and read meters to measure energy use for billing purposes, restore power after faults and emergencies happen due to severe weather events and other causes beyond our control, and communicate outage and restoration information.

2.2.1 Relevant network operator instruments

A key element of our role relevant to the GPS is to provide access services to parties who request to connect to the regulated NT networks. The key instrument that the network operator administers for this purpose is the *Network Technical Code (NTC)*.

The NTC has two elements: the network technical code and the network planning criteria. For the purpose of this consultation, we use the term NTC to refer to both elements.

The network technical code portion of the document is applicable to all equipment connected to our network but particularly generators and large loads. It covers:

- network performance criteria including frequency, quality of supply, stability, load shedding, reliability, steady state criteria and safety and environmental criteria;

- technical requirements of users' facilities including the connection of generators and loads and protection requirements;

- inspection, testing and commissioning;

- power system security;[12] and
- metering.

The network planning criteria portion of the document details the criteria used for assessing plant and equipment performance and response to power system events. These cover matters such as plant and network performance to support frequency events, voltage events, stability events, system reserve, reliability of supply and quality of supply. Power and Water apply these to ensure the regulated networks:

- meet high safety standards;
- provide a high quality, reliable and secure electricity supply;
- meet environmental standards; and
- optimise equipment utilisation.

2.3 What the GPS do and why we're updating them

The GPS are established under the NTC, the SCTC and the SSG are being updated to ensure alignment.

The GPS set conditions generators must meet for connection to the grid. These are important because they ensure that the system can be managed to balance supply and demand in real time to avoid customer outages. They do so by making sure the levers that System Control needs to do its job are there when Power and Water need to call on them.

The key levers Power and Water need in the NT have been explained throughout our consultation process, and are linked to dispatchability and predictability. Throughout the rest of this paper, we elaborate on why these are needed and how Power and Water are proposing to ensure they remain present amid our transition to a greater level of asynchronous renewable generation.

The reasons Power and Water are updating the GPS are twofold:

- If we do nothing, we will rapidly lose dispatchability and predictability across the available generation fleet, and consequently:

- be required to constrain the dispatch of asynchronous renewable generators and thereby frustrate the transition to renewable energy generation; or
- be required to operate higher levels of spinning reserve which will, at times of low load, require asynchronous renewable generators to be constrained and thereby frustrate the transition to renewable energy generation; or
- be unable to perform our role of keeping the lights on; and

- Action 4(c) of the NT Government's Renewable Energy and Electricity Market Reform Implementation Plan 2018-2020 requires us to do so, to play our important technical power system security role in our renewable energy transition.

[12] Applicable provisions on power system security have been moved to the SCTC as the appropriate code for power system security matters.

2.3.1 What do the GPS do?

The GPS describe the technical capability requirements for generators that, if met, mean the generator will automatically be connected to the power system. The GPS are the NT equivalent of the National Electricity Rules (NER) chapter 5 Schedule 5.2.

The GPS can be broadly grouped as:

- Capability to remain in continuous operation under prescribed system normal and abnormal conditions;
- Capability to support power system security during abnormal conditions; and
- Meeting a prescribed level of predictability and dispatchability.

Each of the GPS requirements, whether meeting the automatic standard or a negotiated standard, will be documented (between the generator and Power and Water) and compliance must be maintained for the duration of the connection.

The GPS provide the System Controller with the necessary supply side levers to manage power system security. However, the GPS: do not describe how a generator is dispatched; do not describe power system security constraints; and do not rely on the presence or absence of an energy or ancillary services market.

The SCTC and SSG describe the framework for dispatch of generators to meet both system demand and power system security reflecting NT Government electricity market policy decisions for each regulated power system. The SCTC is the NT equivalent of NER chapter 3 and 4 (Market Operations and Power System Security).

2.3.2 What is not being updated?

Power and Water is not updating its processes for dispatching generation beyond what is required in terms of forecasting to accommodate intermittent renewables as discussed during consultation.[13] The methods of dispatch are an important consideration to maintain system security and to the economics of generators' current and prospective investments. They are thus relevant to many of the issues discussed in the GPS review consultation. However, they are unaffected by the proposed code amendments arising from this GPS review.

The proposed GPS will continue to apply to all NT regulated power systems. This means their design continues to be fit for use with and without a competitive wholesale energy market.

For potential industry initiated code changes *other than* those directly required to implement the GPS, Power and Water has developed an improved process for dealing with stakeholder code change requests. This is summarised in Appendix F.

2.4 Policy context and intent

These GPS address two important policy drivers:

[13] Updates on both security and market dispatch arrangements are likely to be required in the future to facilitate competitive tensions between generators of varying technology in a secure manner.

1. Establishing fit-for-purpose NT regulatory instruments amid the transition of various aspects of NT energy regulation to the national regime; and
2. Implementing a key action from the NT Government's Roadmap to Renewables.

It also seeks to support development of the competitive NT electricity market.

2.4.1 Establishing fit-for-purpose NT regulatory instruments

On 1 July 2015, the NT Government introduced the *National Electricity (Northern Territory) (National Uniform Legislation) Act 2015* (the Application Act), which transferred economic regulation of prescribed electricity networks from the Commission to the Australian Energy Regulator (AER), and provided for the adoption of the National Electricity Law, the NER and the National Electricity Regulations on 1 July 2016.

Consequently, the NT Government has been progressively applying the NER, with necessary derogations and transitional arrangements, through a series of reform packages comprising regulations under the NT Application Act. Package 3, which included the application of the NER Chapter 5 third party access framework, came into force on 1 July 2019, to align with the repeal of the NT Third Party Access Act.

Because related (NT and national) reform programs were ongoing during the development of Package 3, NER arrangements for generator technical standards were not applied in the NT in Package 3, and are to be deferred for consideration in a future NER application package.[14]

A number of sections of the NER have been deferred for consideration. These include:

- rule 5.3.4A, which allows for negotiation of access standards;
- rule 5.3.4B, which concerns system strength remediation for new connections;
- rules 5.20A-5.20C, which concern frequency management planning, inertia sub-networks and requirements, and system strength requirements; and
- schedules 5.1a-5.3a, which set out system and technical access standards.

However, to ensure a functional framework, existing generator technical standard arrangements in the NT will continue to be relied on. As an interim measure, where relevant, references to schedules 5.1a-5.3 and Chapter 4 are replaced with references to 'jurisdictional electricity legislation' and explanatory notes clarify the subject matter of the relevant jurisdictional arrangements to ensure alignment between the NER third party access arrangements and supporting technical standards.

As a result of these progressive changes, Power and Water must incorporate equivalent NT requirements fit for our NT power systems into the jurisdictional instruments (i.e. the NTC and SCTC).

Power and Water recognise that divergence from NEM or WEM requirements can create challenges for generators and generator proponents. Our GPS development approach has therefore been to adopt new standards based on the equivalent NER Chapter 5 Schedule 5.2 requirements, except

[14] Chapter 4 of the NER addresses Power System Security, and currently states that "[t]his Chapter has no effect in this jurisdiction (see regulation 5A of the *National Electricity (Northern Territory) (National Uniform Legislation) (Modification) Regulations).* The application of this Chapter will be revisited as part of the phased implementation of the Rules in this jurisdiction."

where adoption in the NT would prevent System Control having the necessary levers of predictability and dispatchability to ensure power system security in the NT power systems.

In addition to the changes arising from the GPS review, Power and Water notes that the heads of power referred to in several places in the NTC and SCTC and SSG change with the repeal of the *Electricity Networks (Third Party Access) Act 2000* (and the Third Party Access Code that is a Schedule to that Act) with effect from 1 July 2019. Where applicable, Power and Water have updated references in the NTC and SCTC and SSG to refer to the NT NER, *Electricity Reform Act* or Electricity Reform (Administration) Regulations as appropriate.

2.4.2 Implementing the Roadmap to Renewables

The NT Government is undertaking a suite of reforms to promote renewable energy in the NT electricity supply industry, and to accommodate the growing number of proponents who have expressed interest in connecting to the NT power systems.

One of the short-term actions is to modify the network connection process to accommodate the characteristics of large-scale renewable technologies and increasing penetration of renewable energy while maintaining power system security and reliability. This action was specified in 4(c) of the NT Government's Renewable Energy and Electricity Market Reform Implementation Plan 2018-2020. Power and Water was assigned this action.

Among the key principles of the NT Government's Roadmap to Renewables are:

- a requirement to maintain energy security, reliability and stability during the transition to renewable energy; and
- a commitment to implement the transition at least cost to customers.

This was reflected in the NT Government's response to the recommendations of the Roadmap to Renewables, wherein on the recommendation of policy alignment the NT Government stated:

> *While government will seek to utilise renewable energy, subject to its availability and ability to deliver secure, reliable and least-cost electricity, policy initiatives will need to be carefully managed to avoid unintended consequence such as price increases for other electricity consumers.*[15]

This guidance has informed our approach to this review as discussed in section 2.6, including our least cost approach to maintaining current levels of energy security, reliability and stability in the absence of a formal standard, during the transition to asynchronous renewable energy.

During our second round consultation process, some stakeholders still questioned the alignment of the proposed GPS with the Roadmap to Renewables policy position. Tetris Energy stated:

> *The roll out of the new GPS should integrate with the Road Map to Renewables Policy*

The GPS as proposed facilitate high penetration of renewable energy generators into the energy supply industry at the least cost to consumers. This is achieved by ensuring the system can technically support a high penetration of PV generation rather than relying on synchronous generation to off-set

[15] https://roadmaptorenewables.nt.gov.au/roadmap-to-renewables-expert-panel-report/government-response.

intermittency and provide all 'non-energy' services. The GPS also seek to facilitate least cost outcomes by placing the risk with those best placed to manage it.

NT Solar Futures sought an obligation on System Control to maximise renewable energy, and further stated that System Control's dispatch management focus should not be on system security and reliability to the detriment of renewable energy.[16]

The Codes must reflect the underlying legislative framework, including the rights, obligations and objectives of market entities. The NT Solar Futures proposal is inconsistent with the framework governing the system control function and the industry more broadly, and paramountcy of system security and economic efficiency requirements. Power and Water believes that the proposed inclusion would require government policy and amendments to the *Electricity Reform Act 2000*.

2.4.3 How the GPS will fit in the NT Electricity Market (NTEM)

The GPS will affect the costs of generators seeking to connect to the system. Because these commercial drivers will affect generators' investment decisions, it is important that this round of GPS changes considers how the standards can support certainty over the foreseeable future.

We have therefore considered the three key phases of the NT energy market, these being:

- the current Interim NT Energy Market or I-NTEM;
- the proposed transitional I-NTEM 2.0 amendments; and
- the future state NTEM.

Power and Water continues to work with the Department of Treasury and Finance in the GPS development to ensure alignment with the I-NTEM 2.0 and NTEM designs. This impacted the wording for provisions such as C-FCAS capability which has had its operation under the I-NTEM and the transitional path to the NTEM explained for clarity in the consultation material.

The majority of the GPS are unrelated to market reform as they relate to the adequate performance and capabilities of generators to ensure plant operates in a stable manner and there are appropriate security reserves to call upon.

2.5 NT context and consequences

To establish fit-for-purpose NT GPS requirements, their development must be firmly grounded in the physical realities of our regulated NT power systems. These differ markedly from those in the NEM and WEM.

Some of the key differences to the NEM include:

- *Apply to multiple power systems* | The NT GPS apply to both the Darwin Katherine Interconnected System (DKIS) which has a competitive wholesale market (the I-NTEM), as well as the Alice Springs and Tennant Creek power systems that do not operate wholesale markets. This means they must provide robust minimum requirements that provide our system control the capability to ensure secure, reliable and stable system operation under both types of generation dispatch environment.

[16] Submission by NT Solar Futures dated 18 July 2019, at pages 2 and 3

- *Scale* | The size of individual generators as a proportion to the total system load is significantly higher in comparison to the NEM, which means a single generator can significantly impact system security. For example, in relative terms given the size of maximum demand between the NEM and the DKIS, a 20 MW generator on the DKIS is equivalent to a NEM generator of approximately 2,200 MW. This is three times larger than the largest single NEM generation unit (Kogan Creek – 744 MW). We note that some of the proposed PV generators (solar farms) in the NT are in the order of 50 MW in size. Given their relative size these asynchronous generators present unique issues for NT system security.

- *No ancillary service market* | There is currently no market for power system security services in the DKIS and there is no intention to introduce a market in the Alice Springs or Tennant Creek systems.

- *No interconnection* | There is no interconnection to other geographically or energy source diverse markets, which means the NT systems have to be self-reliant for all system security requirements

- *PV is the dominant form of renewable generation* | The current pipeline of renewable technology is PV so there is limited diversity in energy source. Diversity from different generation sources will often result in generators naturally offsetting system limitations and energy intermittency, whereas our lack of diversity in renewable energy sources will mean our system cannot benefit from such off-setting effects.

- *Hydro is non- viable* | There are limited economically viable opportunities as the NT terrain does not lend itself to long term hydro based energy storage technologies. In the NEM hydro is used for energy storage to offset intermittent sources. This is demonstrated by Tasmania's proposed 'battery for the nation' and Snowy 2.0, and underpins the NEM system security.

Power and Water operates the networks and controls the systems for three regulated power systems and operates the I-NTEM, which only operates on the DKIS.

The challenges of our NT power systems and requirement for a bespoke system security solution in the GPS design was explained during our June 2019 engagement workshop by energy expert David Swift as follows:[17]

> *The NT system is quickly moving to the leading edge of world experience with high levels of [variable renewable energy (**VRE**)] VRE.*
>
> *That VRE is likely to be dominated by solar PV, which is the most variable.*
>
> *NT systems are islands (unable to draw on external support) and there is no known potential for pumped hydro storage. These are important in many international examples with high VRE.*
>
> *Efficiently maintaining security and reliability requires end-to-end attention – from the generator performance standards through to the market arrangements.*
>
> *Need to balance use of regulation and standards with financial incentives*
>
> *Recognise that the scale of the NT systems make it difficult to justify the cost and complexity of the systems operated by AEMO and other leading International operators.*

[17] David Swift, *Lessons from the NEM,* workshop presentation, 26 June 2019

They were also acknowledged by Proa Analytics in its submission:

> *Power systems of the size of the NT would certainly need greater reliability requirements than a system such as the NEM.*[18]

2.5.1 How the system is run now

The way Power and Water currently maintain power system security reflects lessons from the past and our deep knowledge of the capabilities of the system. The current SSG was developed following a period of significant outages in 2014, and represent the results of collective learning about the levels of reserves required and reasonable contingencies management practices in our circumstances.

Two key requirements of the SSG relate to spinning reserve:

- A minimum of 25 MW of spinning reserve; and
- A minimum of two Channel Island Frame 6 turbines spinning at 26 MW or below, on different electrical points of connection.

These requirements were adopted following the December 2014 system black (and following a period of about 17 under frequency load shedding events during the previous 12 months caused by a single generator contingency). Since that point the incidence of under frequency load shedding due to a single generator contingency has dropped to on average less than 1 per year.

As our modelling conducted during this development shows clearly, the current SSG spinning reserve requirements will be unfit in a new industry with large amounts of intermittent generation, Power and Water will need to transition to the more sophisticated approach based on managing Contingency Frequency Control Ancillary Services (C-FCAS).

With that said, for modelling purposes a base case needs to be taken and options reviewed against it, and hence Power and Water are using the existing requirements for spinning reserve contained within the SSG.

Managing for credible contingency events

Our system control practices have to recognise that the incidence of individual generator units tripping off-line is quite frequent – multiple times per week. A generator trip can be caused by a wide range of incidents, and is one of the primary contingency events Power and Water manage from a secure system perspective.[19]

Although the SSG requires that a minimum of 25 MW of spinning reserve is held, due to the size of the generators in the system and their minimum safe loadings (and other constraints on operation), the system is actually generally operated with a higher level of spinning reserve – at an average level of around 40 MW.

There have been occasions where short term changes in roof-top solar production were sufficiently large that had Power and Water been running at 25 MW of spinning reserve at the time, System Control would have had to take rapid action to avoid customer outages. As we discuss at length later

[18] Submission by Proa Analytics dated 18 July 2019, at page 1.

[19] As opposed to managing network outages or the islanding of the system due to the 132 kV line, which are significant causes of customer events, but are not relevant events for the purpose of considering the SSG and new solar generation, given that such a network event will affect all generation in a similar manner.

in this document, as the level of solar penetration increases, the SSG will need to be significantly altered, and larger spinning reserves (or other similar contingency management actions) will be required. There is currently approximately 50 MW of rooftop solar in the DKIS which is all asynchronous generation. The growth of rooftop solar has led to short term (< 5 minutes) large swings in demand. This has resulted in the spinning reserve requirements being breached on multiple occasions.

With increasing levels of large-scale asynchronous penetration, the risk of an unexpected output reduction on a PV generator due to cloud coverage occurring simultaneously with a contingency event on another generator becomes increasingly likely. This coincident event would likely cause significant disconnection of customers. A credible example of this would be if a synchronous generator dispatched at 30 MW trips at the same time as a cloud causes a 25 MW drop in an asynchronous generator's output. This would result in a 55 MW drop in production and would (to a high likelihood) cause load shedding under the current spinning reserve arrangements. This would have a similar customer impact to a recent event where two generators were tripped, losing a similar level of output, which resulted in over 9,000 customers losing power.

If you take this to the extreme of the largest proposed asynchronous generator and the largest synchronous generator dropping output simultaneously, the system could see more than 90 MW reduction in output.

We have conducted modelling to understand the risk and consequences as follows:

- We have conducted a simulation of 2017, using actual demand and offers from Territory Generation (TGen) and EDL units, and then included indicative asynchronous solar production (including solar forecasts) for the asynchronous generators that have applied to connect—totalling about 120 MW in capacity.
- We have then looked at the number of daylight 30 minute periods where the SSG would have been breached[20] due to the error between the forecast and actual production for these asynchronous generators, at different levels of assumed forecast accuracy.
- It should be noted that this modelling provides 'best case' outcomes as it does not assume any relationship between the forecasting errors of different generators. The modelling outcomes further trend towards 'best case' outcomes by assuming that the additional spinning reserve above the minimum that was available in 2017 as a result of the size and merit order of dispatch of the existing generators continues.
- We have set out the results in Table 1.1.

[20] A breach in this case simply means that we had less than 25MW of remaining spinning reserve.

Table 2.1: Percentage of Daylight Periods with SSG breach

		Percent of periods accurately forecasted			
		95%	90%	80%	50%
Maximum Error magnitude	5%	0.76%	1.52%	3.42%	6.84%
	10%	0.76%	3.04%	3.80%	6.84%
	20%	1.52%	3.04%	4.18%	13.31%
	50%	4.18%	7.22%	16.35%	41.44%

Implications

The above 'do nothing' analysis is simply illustrative because clearly Power and Water would not allow the increase in load shedding to occur from coincident forecasting errors and generator contingencies. It illustrates that relying on the current Spinning Reserve arrangements is not sufficient and Power and Water need to act now to ensure we have the levers to maintain power system security. The questions is: what should we do?

The fundamental issue is that Power and Water require high levels of predictability and dispatchability from all generators:

- To achieve high levels of predictability and dispatchability, Power and Water propose short term forecasting requirements on all materially large generators.
- We will aim over time to move to a C-FCAS based security management regime, which Power and Water has already foreshadowed in the SSG.
- We will require all generators to be capable of participating in the FCAS arrangements – this is already a requirement included in the proposed NTC 3.3.5.11 (generators need to demonstrate capability for all forms of FCAS).

2.6 Regulatory requirements for the GPS review

The code amendments that give effect to the generator performance standards must be approved by the NT independent regulator, the Commission. This process is outlined in section 1.2.

The Commission will consider our amendments under the *Utilities Commission Act*. Relevantly, section 6(2) of the Act states:

> *'In performing the Utilities Commission's functions, the Utilities Commission must have regard to the need:*
>
> *(a) to promote competitive and fair market conduct;*
>
> *(b) to prevent misuse of monopoly or market power;*
>
> *(c) to facilitate entry into relevant markets;*
>
> *(d) to promote economic efficiency;*
>
> *(e) to ensure consumers benefit from competition and efficiency;*

(f) to protect the interests of consumers with respect to reliability and quality of services and supply in regulated industries;

(g) to facilitate maintenance of the financial viability of regulated industries; and

(h) to ensure an appropriate rate of return on regulated infrastructure assets.'

The Commission has also relevantly foreshadowed in its 2016-17 Power System Review that it will:

'consider the cost trade-offs between GPS, ancillary services and network investment as part of its assessment of System Control's proposed GPS'.[21]

In developing, consulting on and refining our proposed amendments Power and Water have considered these requirements and guidance, and pursued an approach that Power and Water consider will best achieve them. Indeed, several of these considerations are of key importance to the GPS Power and Water have developed and to how Power and Water have considered evidence and feedback in arriving at the proposed code amendments. The table below explains what Power and Water consider to be the implications of these threshold provisions for our approach to this review.

Table 2.2: Complying with the regime that governs our code amendments

Utilities Commission Act requirement	Implications and resulting principles for how Power and Water approach the GPS review[22]
Promote competitive and fair market conduct	The GPS should: • Be technology agnostic as far as practicable and thereby not create market power for one generator over another based on technology • Not raise the costs of subsequent renewable generators based on the treatment of first entrants i.e. not create market power based on the order in which proponents connect to the NT grid (i.e. beyond the competitive advantage that first movers may gain in a competitive market)
Prevent misuse of monopoly or market power	Well-designed grandfathering and transitional arrangements for existing and inflight renewable proponents, ensuring arrangements do not become a source of market power
Facilitate entry into relevant markets	Notwithstanding the necessary timing of this review, Power and Water is seeking to establish GPS that provide certainty to potential investors by taking a long term / 'no regrets' view to establish a 'Framework for the Future', through being: • Clear about obligations • Forward-looking to support GPS that can be stable over the foreseeable future • Transparent about the technical challenges in the NT system and the relative cost/viability of alternative options considered • Intent on having standards in place prior to the connection of first mover renewable proponents

[21] Commission, Power System Review 2016-17, p. iv.
[22] These elaborate on the principles that have previously been presented in our public consultation.

Promote economic efficiency	The GPS should support the lowest total cost of reliably providing energy whilst facilitating the connection of asynchronous renewable energy technologies The total costs should be considered having regard to cost trade-offs between GPS, ancillary services and network investment Risk should be placed with those best able to manage it at least cost
Ensure consumers benefit from competition and efficiency	Our Framework for the Future means Power and Water are facilitating renewable generation entry in a manner that minimises the total cost of reliably providing energy whilst facilitating a greater share of renewable generation
Protect the interests of consumers with respect to reliability and quality of services and supply in regulated industries	Our primary focus is keeping the lights on while facilitating increased connection of asynchronous renewable energy and storage technologies

These *Utilities Commission Act* requirements have also informed our approach to assessing alternatives, in particular our least cost approach rather than net benefits approach.

Some stakeholders submitted to our second round consultation[23] that Power and Water should have performed a cost benefit study of alternatives. For example, EDL submitted that:

> *meaningful assessment of the net costs of the GPS changes doesn't yet appear to have been undertaken*[24]

We have developed our analytical approach in line with our statutory function and the *Utilities Commission Act* requirements. As system controller, Power and Water must monitor and control the operation of the power system with a view to ensuring that the system operates reliably, safely and securely in accordance with the System Control Technical Code.[25] As a licensed network provider, Power and Water must comply with all applicable regulatory instruments, and operate, maintain and protect the network in accordance with the Network Technical Code.[26]

We understood the *Utilities Commission Act* requirements to promote economic efficiency and protect the interests of consumers with respect to reliability and quality of services and supply in regulated industries, as supporting adopting a least cost approach to performing our system control functions.

Under the NT's regulatory framework, the inherent cost benefit analysis (i.e. in choosing between security and reliability, and the regulated power systems' shares of dispatched renewable energy) does not lie with Power and Water. Neither Power and Water nor the Commission has any legislated head of power to value renewable energy over other energy sources when discharging our power system security and reliability functions. As such, the generator performance standards were assessed on a basis of '*least cost to maintain security, reliability and stability of the NT power systems*'. This

[23] See submissions by EDL, Tetris Energy, and Darwin International Airport.
[24] Submission by EDL dated 26 July 2019, at page 1.
[25] Section 38(1) of the *Electricity Reform Act* 2000
[26] Clauses 10 and 16, Network Licence issued to Power and Water Corporation

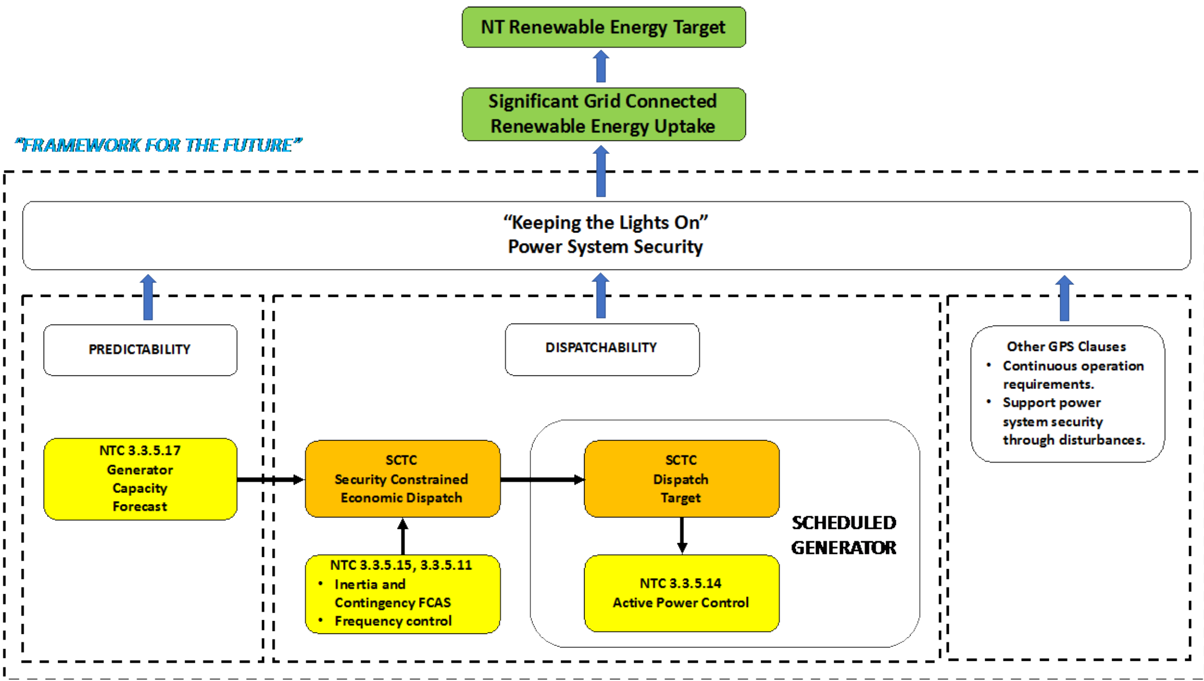
differs from a formal cost benefit analysis that would be needed to justify a policy change in the relative priorities of system security and renewable energy.

We note that under this least cost approach, our proposed GPS is consistent with some of the market solutions stakeholders have cited as preferable alternatives in their opinions (notably, a centralised battery solution). The only area that forms a non-negligible generator cost is in the capacity forecasting requirements. As batteries are well established to provide short term reserves rather than spinning reserve held by gas turbines, generators are able to advance these as market solutions where they are a more commercial compliant alternative to individual GPS compliance solutions.

2.7 GPS framework for the future

The considerations in the preceding sections, their interrelationship with this GPS review and the instruments Power and Water are amending (including the specific clauses that relate to key issues covered in sections 5 to 8 of this paper) are illustrated in the following figure. This framework for the future was the focus of our March 2019 Supplementary Consultation Papers and remains relevant to the content of this application.

Figure 2.1: Framework for the future overview



3. Power and Water's consultation on GPS

3.1 The consultation process

The consultation process to date for incorporating the GPS in the NTC and SCTC (the codes) has included:

- 18 December 2018 – Release of the proposed changes to the codes and overarching consultation paper
- 18 February 2019 – Public information session held for stakeholders on proposed code changes

- 12 March 2019 – Release of a supplementary consultation on removal of semi-scheduled generator classification and capacity forecasting
- 20 March 2019 – Release of a supplementary consultation on contingency FCAS (C-FCAS) / Inertia proposed standard
- 29 March 2019 – Round 1 consultation closed, with 13 submissions received from 10 stakeholders
- 21 June 2019 – Release of round 2 consultation pack, including Entura's technical verifier's report
- 26 June 2019 – GPS round 2 consultation workshop
- July 2019 – Published responses to workshop questions, conducted one-on-one meetings with stakeholders, and received 11 stakeholder submissions.

Power and Water acknowledges and appreciates the effort of stakeholders in participating in and making submissions to our consultation on the proposed Code changes. This consultation has informed the proposed NTC and SCTC amendments in this application.

3.2 Approach to feedback

As highlighted above, our approach has been to seek the least cost way to continue to meet our statutory functions to achieve the safety, security, reliability and efficiency of power system operations, now and in the transition to a renewable energy future.

We carefully and objectively considered all feedback from stakeholders, and accommodated proposals where practical and sensible applying a 'no regrets' philosophy. We obtained independent advice and technical verification where warranted, and assessed the best way forward based on:

- our deep understanding of the NT system;
- effects on system security and reliability; and
- consideration of the objectives set out in the *Utilities Commission Act,* including:

- promoting a competitive and fair market;
- preventing misuse of monopoly or market power;
- facilitating entry into relevant markets;
- protecting the interests of consumers with respect to reliability and quality of services and supply; and
- promoting economic efficiency through minimising total costs by placing risks with the parties best placed to manage them.

We are confident that our proposed GPS code changes are necessary, reasonable, and appropriate for implementing in the NT.

Stakeholder feedback received up to June was considered and addressed in our round 2 consultation pack, and is not addressed further in this application. Submissions in response to round 2 consultation pack are summarised in Appendix D which sets out our responses or cross references where they are addressed within this application or earlier papers.

4. Overview of proposed code changes

4.1 NTC

The proposed changes to the NTC can be categorised thematically as:

- Establishment of a dedicated section 3.3 for the new proposed GPS to enable high penetration of variable renewable energy while maintaining reliability at the lowest cost to customers. This was the primary driver for changes to both of the Codes.
- Clarity around the application of the proposed NTC changes for existing generators (grandfathering), modifying existing generators and generators connecting after 1 April 2019 including transition to compliance arrangements.
- Removal / transfer of power system security related clauses so they are consolidated in the SCTC.
- Removal of metering clauses (section 10) as they are now covered by the NT NER Chapter 7A.

The proposed section 3.3 specifies the 'Requirements for the Connection of New Generators', and largely follows the NER Schedule 5.2.5 which can be characterised as set out in Table 4.1.

Table 4.1: Network Technical Code clause 3.3 requirements

Requirement	Provisions
system normal operation	3.3.5.1 - Reactive power capability** 3.3.5.2 - Quality of electricity generated
generating systems to remain in continuous operation	3.3.5.3 - Generating system response to frequency disturbances** 3.3.5.4 - Generating system response to voltage disturbances** 3.3.5.5 - Generating system response to disturbances following contingency events** 3.3.5.6 - Quality of Electricity Generated and Continuous Uninterrupted Operation 3.3.5.12 - Impact on Network Capability 3.3.6.1 - Remote Monitoring and Control 3.3.6.2 - Communications Equipment
generating systems to support the power system during disturbances	3.3.5.7 - Partial Load Rejection 3.3.5.8 - Protection of Generation Units from Power System Disturbances 3.3.5.9 - Protection Systems that Impact on Power System Security 3.3.5.10 - Protection to Trip Plant for Unstable Operation 3.3.5.11 - Frequency Control 3.3.5.13 - Voltage and Reactive Power Control 3.3.5.15 - Inertia and Contingency FCAS 3.3.5.16 - System Strength
predictability and dispatchability	3.3.5.17 – Capacity Forecasting** 3.3.5.14 – Active Power Control**

** *Clauses that have been modified following stakeholder feedback during the consultation process*

To provide flexibility during the transition to renewable energy and encourage innovative solutions, Power and Water have deliberately departed from the NER only in defining automatic access standards. We have then taken selected clauses from the NER 5.3.4 and applied these to NTC clause 3.3.5 regarding a framework for proposing a negotiated access standard that is as close as possible to the outcomes sought under the automatic standard.

4.2 SCTC

The changes to the SCTC are relatively minor and principally around providing greater clarity around any power system security matters that were duplicated in both Codes and had the potential to conflict including:

- Alignment to the correct jurisdictional legislation following repeal of the Third Party Access Act;
- Clarity regarding the respective roles and responsibilities of the Network Operator and Power System Controller;
- Clarity regarding the classification of new generators and the application of the materiality threshold for automatic application of the GPS; and
- 30 day ahead generator capacity forecast requirements.

Relevant clauses were either modified, transferred or created as a result of the above matters.

Appendix C provides a list of the respective Code specific clause changes proposed.

Part B | Statement of approach to key issues

In support of our application for approval of proposed code amendments, this section provides information on the following key issues that were of particular interest to stakeholders during the consultation process:

1. Application of GPS, grandfathering provisions, and the call for a more staged implementation;
2. Forecasting requirements, and consideration of other options;
3. Removal of the semi-scheduled generator classification; and
4. Requiring C-FCAS capability.

In this part Power and Water discuss each key issue in depth, outlining

- The proposed code amendments and their effect;
- Rationale for the changes and preferred approach, including where relevant:
  - What problem the amendment seeks to address;
  - Why Power and Water considers the proposed amendment is preferable to alternatives it considered and stakeholders raised;
- How the proposed amendment aligns with the requirements that the Commission must consider under section 6(2) of the *Utilities Commission Act*.

5. Application of Generator Performance Standards – Grandfathering and modifications to existing generators

5.1 Proposed code amendments and their effect

New provisions are set out in clause 12 of the NTC, and supported by a new clause 6.14(l) in the SCTC, and NT NER clause 5.3.9.

These code provisions provide as follows.

- **Existing connection pre 1 April 2019** - Grandfathering provisions apply to generators physically connected prior to 1 April 2019 (i.e. they do not apply to connection applications, but only to a generating system that is electrically connected).

- These generators will be assessed without modification against the proposed GPS, but need only meet NTC Version 3, as in force immediately prior to the date when Version 4 comes into effect.
- Post April 2019 modification of plant that has been grandfathered will have the 'ratchet' approach i.e. it may not reduce capability for any performance standard to below its pre-modification state, but it could remain the same. That is, like for like replacements are accepted. As per NT NER clause 5.3.9, System Control (NTESMO) should be notified of any proposed alteration to generating systems, so as to assess the impact of proposed changes and decide whether they should be approved.

- **Interim connections between 1 April 2019 and code approval –** There will be a grace period for generators who physically connect during this interim period, during which such generators are not required to comply with agreed components of the GPS, for periods specified in a schedule to the NTC. The grace period extends beyond the code approval date, in accordance with documented arrangements for specific technical obligations and connections. During this period, the

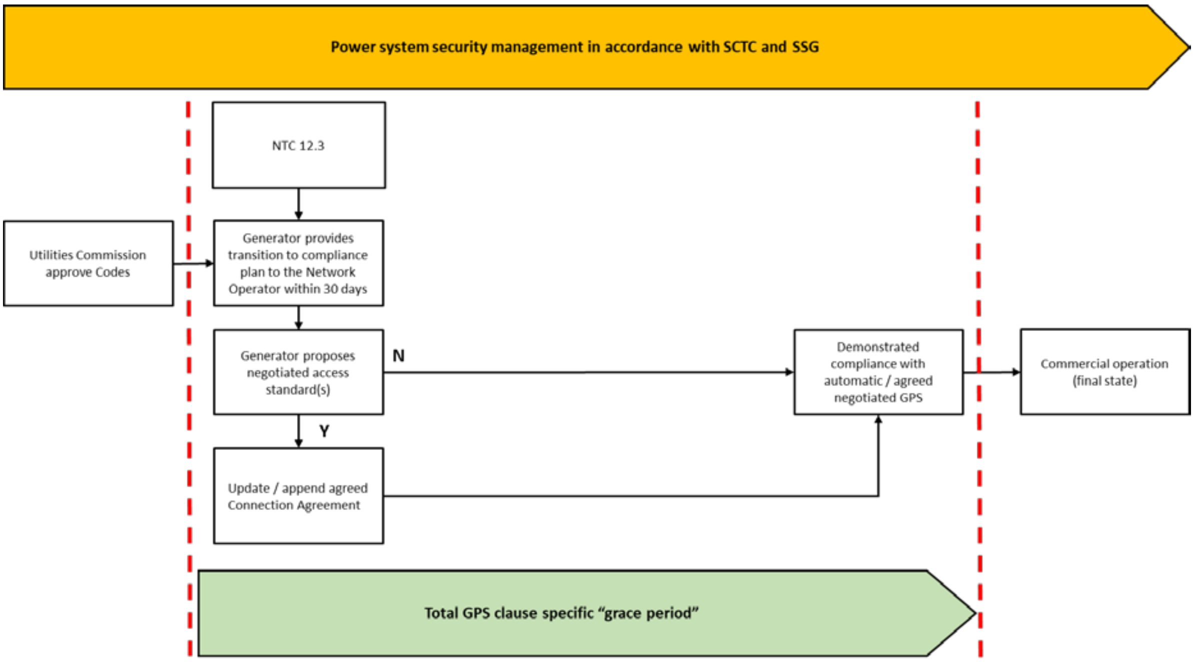
  - New provisions in NTC clause 12.3 provide that, where a grace period for a technical requirement is specified in a new Schedule S4, a generator will not be regarded as in breach of the NTC if:

    - within 30 days of the new code commencing, it submits a plan setting out how it will ensure compliance with technical requirement(s) from the end of the applicable grace period, and it complies with that plan; and

    - it complies with that technical requirement after the relevant grace period.

  - There are new provisions in clause 12.3(b) and (c) regarding the content of that plan.

Figure 5.1: New grace period provisions



- **Post code approval connections -** Generators (including newly created or additional generating systems at any point in the power system and 'behind the meter') physically connected after code changes are approved must comply with the new GPS obligations.

The grandfathering and transitional provisions have been added in response to stakeholder feedback. Power and Water believes that it can accommodate these further transitional provisions, provided that it can deal adequately with system security both in the short and long term. This means that:

1. Though a generator that connects in the interim period may be protected from rule, code and licence non-compliance with the GPS during a transition period, the level of performance compliance and capability will drive the level of constraint required to maintain

system security. Hence, a non-conforming generator is more likely to be constrained by the system controller in order to ensure system integrity.

2. Each new generator should be aware of the proposed GPS obligations and their commencement, and required to transition to compliance. The generator should make an informed decision about the optimal timing of that compliance.

Any future derogations would be considered only if they will not adversely affect network capability, power system security, quality or reliability of supply, intra-regional power transfer capability or the use of a network by another User. Where agreed, temporary derogations would be set out in the relevant connection agreement.

5.2 Rationale for the changes and our preferred approach

The problems that the GPS and any transitional or grandfathering arrangements must address are:

- Legacy generators need clarity on how upgrades to their assets will interact with the GPS grandfathering provisions.
- The new GPS have been developed in order to facilitate the transition to renewables, so it is logical to confirm the capabilities of existing generators against the GPS and therefore System Control would need compliance data measured against the new standards.
- The conditions that have given rise to the need to adopt these new GPS are equally applicable to the new generation currently under construction.
- Providing certainty to new generators under construction as well as future connecting generators.

Power and Water considers that the proposed amendments are preferable to alternatives it considered and stakeholders raised. At a high level, the alternatives available were:

- apply the new GPS to all generators without exception, from the outset;
- apply the GPS only to future generators seeking connection;
- some grandfathering, and a path to alignment or
- staged adoption or trials.

To meet the 50% renewable energy target, Power and Water must plan for managing our power systems where potentially more than 100% of the system demand is being delivered by asynchronous energy at points of the day, with surplus being stored for later use. We must also plan for managing our power systems where a significant component of the generation is asynchronous solar.

Within this paradigm it makes little sense to create default rules for traditional (gas) generation, and to then depart from those requirements as required to enable asynchronous new entrants. Asynchronous renewables will no longer be the 'new technology', but will in fact, for significant periods of the time, be the backbone and dominant energy source for operating our power systems.

Power and Water has applied a 'no regrets' philosophy and holds the view that it is essential to set the 'Framework for the Future' such that the outcomes are consistent with the NT objectives insofar as:

- promoting a competitive and fair market;
- preventing misuse of monopoly or market power; and
- facilitating entry into relevant markets.

In this context, the treatment of generators that are under construction and commenced amid this current review should not face an outcome that creates market power for them, or raises barriers to entry for subsequent generators. Early mover renewable generators should not get an unfair advantage of lower access standards that result in higher entry barriers to subsequent generator developments and higher costs to consumers. Further, our approach will maximise the chances of the available renewables actually being used, rather than constrained off to enable synchronous stabilisation.

Because the system security issues that have driven these GPS changes apply equally to in-flight projects, Power and Water have tried to take a 'no surprises' approach to developing the GPS. This was on the expectation (communicated prior to licences being issued and during the connection process) that the new standards would need to apply to projects under construction.

The impacted generators have been aware from the outset that the GPS were being developed and that they would need to meet those requirements once finalised. In considering the revised position as a result of round 2 stakeholder feedback, Power and Water is of the view that subject to temporary derogations available for generators that connect in the interim period between 1 April 2019 and code changes, the NTC and SCTC changes approved by the Commission will apply to all generators that were not connected at code change commencement.

Staged adoption or trials were considered. Some submissions suggested that the NT follow the developments of other jurisdictions:

> *"In the years ahead as RE and enabling technologies such as solar forecasting and control battery storage continue to develop and improve, the Codes may be reviewed and updated at the appropriate time with contemporary information. This also allows the NT to benefit from experience in other jurisdictions, as they also increase their RE penetration. The current Code reviews would put the NT at a technologically theoretical position, well in advance of the proven approaches of other jurisdictions including the NEM and WEM."*[27]

Or similarly, to trial obligations:

> *"Trial – The current draft standards appear to require an accuracy of forecasts that are based around a much higher level of solar penetration than will occur over the coming years which provides an opportunity to trial and implement these measures over a greater timeframe."*

Put simply, given the small scale of the NT power systems against the rate of renewable energy uptake, the NT simply does not have time to undertake trials or delayed implementation of the GPS that would expose customers to high cost and increased reliability risk. The quantity of Solar PV

[27] Submission by NT Solar Futures dated 18 July 2019, at page 2.

generators that are sufficiently progressed in the connection process such that they are likely to connect in the next 12 months accumulate to ~58 MW. This is compounded by over 50 MW of behind the meter PV, which continues to grow rapidly, seeing the DKIS minimum daytime demand of ~95 MW. Trials or a staged approach to obligations relies on the uptake of the new technology being immaterial to power system security, which is not the case based on the above.

Behind the ~58 MW likely to connect in 12 months there is a further ~200 MW of Solar PV currently under connection application for the DKIS. For this quantity of PV proposed to connect in the near future, it needs to be suitable for operation under arrangements where solar PV is the dominant energy supplier as this will be the case in the immediate future.

Solar PV is the only proposed renewable energy connecting and is the most intermittent of variable renewable energy (VRE) sources. In the DKIS, this means there is no diversification of VRE in current connection applications and the power system is subject to similar weather patterns (geographic dispersion has limited effect on the variability). It also has limited coping mechanisms with no interconnectors and limited economic potential for pumped hydro.

Operating a system with these characteristics is as yet an unsolved technical problem that is not likely to be experienced and resolved by another jurisdiction in the near future – The NT is leading the challenge and must lead in delivering a solution or bear the consequences.

In contemplating the feasibility of staging obligations, Power and Water considered the objectives under the *Utilities Commission Act* and identified the following issues with a staged approach.

- It is likely to significantly increase the cost of connecting future generators (barrier to entry).
- Low utilisation due to higher level of constraint applied to early mover PV (stranded assets not supporting economic efficiency).
- Lack of dispatchability and predictability impede dispatching 100% of demand from solar PV for periods of time (barrier to 50% renewable energy).

5.3 Alignment with *Utilities Commission Act* objectives

The proposed solution aims to:

- promote competitive and fair market conduct;
- prevent misuse of monopoly or market power;
- protect the interests of consumers with respect to reliability and quality of services and supply in regulated industries; and
- promote economic efficiency.

6. Forecasting requirements, and consideration of other options

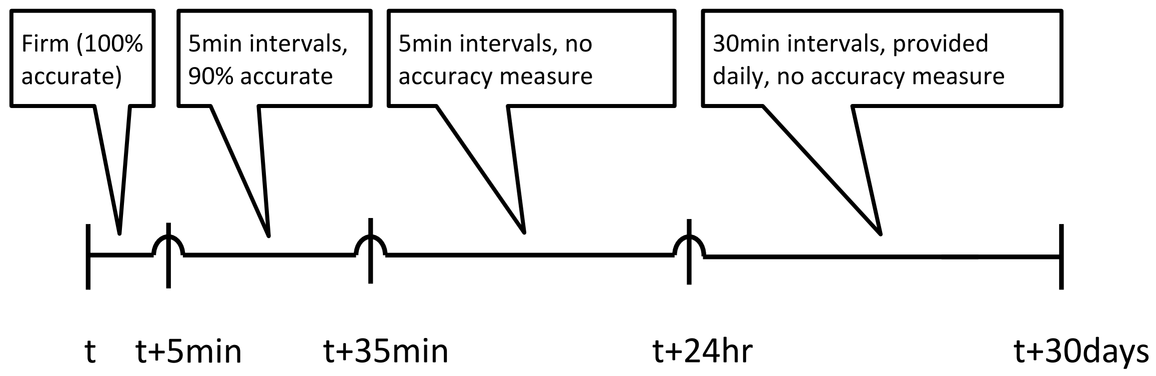
6.1 Proposed code amendments and their effect

New capacity forecasting obligations are set out in NTC 3.3.5.17 under the suite of proposed amendments to NTC clause 3.3.5 that form the GPS.

Our proposed forecasting requirements – which would apply to all generators – and the interactions with the dispatch process are summarised below and illustrated in Figure 6.1.[28] All generators are to provide:

- a rolling 5 minute ahead capacity forecast for 24 hours in 5 minute intervals; and
- a rolling 30 day ahead forecast for capacity in 30 minute intervals, updated daily

Figure 6.1: Timeline of forecasting requirements



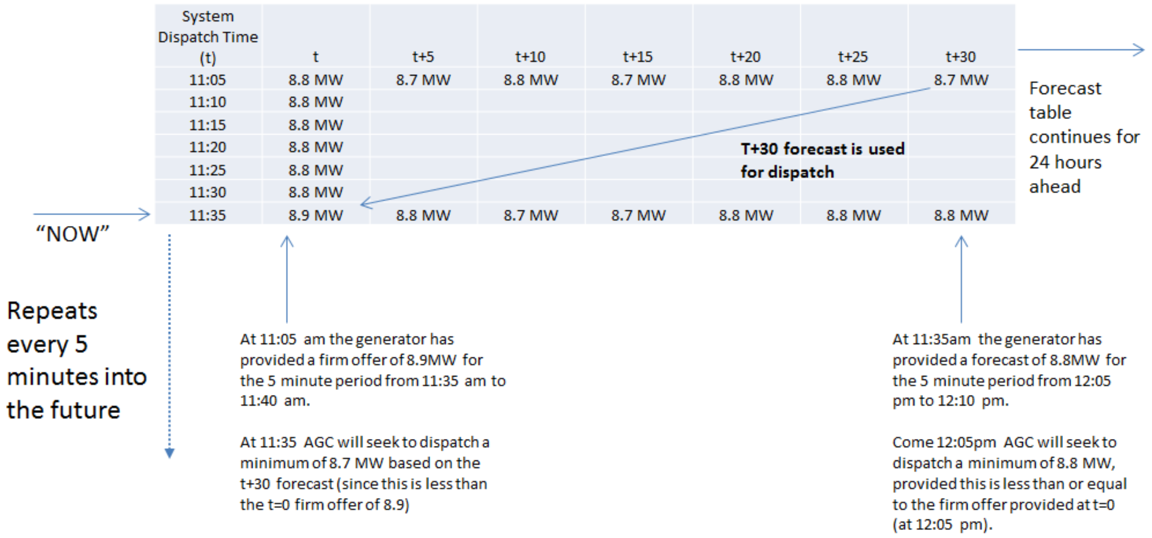
Notice that the forecast provided at t+30 is used in the pre-dispatch decisions, and is the basis on which decisions about the mix of generation to be started and operated are made. It is this quantity that will (potentially) be dispatched at t=0.

In our example below, at 11:05 am the generator forecast provided a 30 minute ahead forecast of 8.7 MW for the 5 minutes from 11:35 am to 11:40 am.

However, at 11:35 am the generator now indicated that their capacity was in fact 8.9 MW. In this case they would (normally) be dispatched to 8.7 MW.

[28] In the following, the term "t" means "the time at which physical dispatch instructions for the next 5 minutes occurs".

Figure 6.2: Forecasting example



The t=0 forecast provided is treated as a **firm offer** of capacity. This means that the plant may be dispatched up to this level, although under normal arrangements it would only be dispatched to the level provided in the t+30 forecast which was used in the pre-dispatch process.

Any additional capacity offered at t=0 may be applied by the system controllers to meet contingency events.

Once a dispatch instruction is sent (at t=0), the plant is expected to meet the dispatched level for every 15 second period within the 5 minute period.

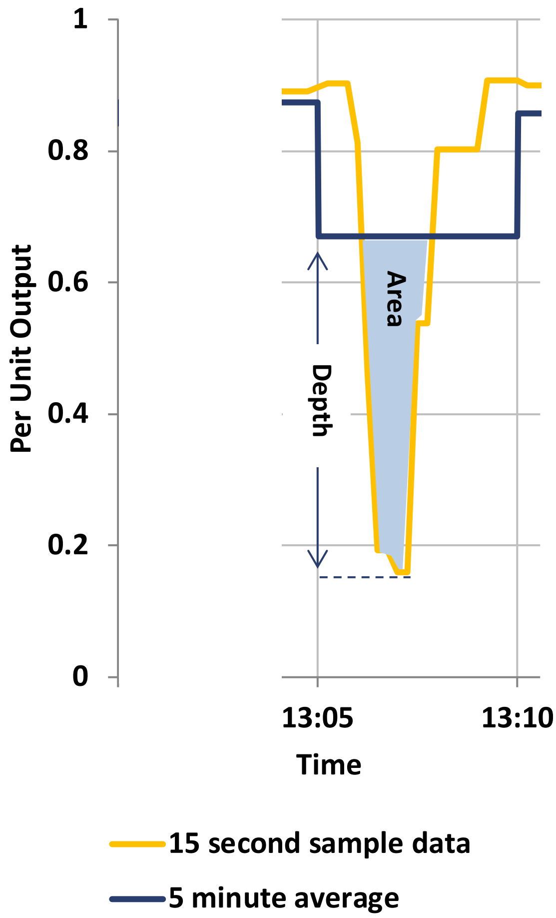
Failure to achieve this means that in future periods dispatch may be de-rated compared to the t+30 forecast and t=0 offers provided by the generator. We note that it is consistent with NT NER 5.7.3 (f)(2) to apply operational restrictions on generators unable to meet the GPS, with the potential to adversely affect power system security.

The proposed obligation is for capacity forecasts not energy forecasts

The proposed requirement is for all generators to provide a capacity forecast, on a rolling 5 minute basis for 24 hours ahead. We are also requiring a 30 day ahead capacity forecast on a 30 minute basis. The forecast is proposed as a capacity forecast. The key difference is that power is an instantaneous physical quantity at a given <u>point</u> in time and measured as mega watts, whereas energy is the average power over a given <u>period</u> of time and measured as mega watt hours.

Figure 6.3 illustrates instantaneous power compared to the 5 minute average (energy).

Figure 6.3: Solar output comparison



A capacity forecast means forecasting a level (for example the blue line[29]) to which the generator is prepared to manage their output for the 5 minute period, continuously supplying this level within the period. That is, a level at which the orange line will never fall below the blue line.

For solar generators, this implies that they need to have some form of smoothing for dealing with the short term power swings (the 'depth'). In the example, a battery that charged when the blue line is above the orange line, and discharged when it is below. In energy terms, smoothing required is represented by 'the area' as shaded in Figure 6.3.

We are requiring that all generators manage (either themselves on-site, or in some other manner) the short term power swings such that the instantaneous power does not drop below the 5 minute forecast provided at dispatch time.

We anticipate that for a PV generator providing this generation capacity forecast is likely to involve a mix of inputs including:

[29] This was the average energy production in Figure 6.4, but here it is used to illustrate a minimum capacity forecast

- A solar forecast – possibly obtained by the generator from a 3rd party - which forecasts the level of solar energy being received;
- A risk management model for that farm – presumably specifically developed by the farm itself – which takes into account the historical performance and known maintenance and other factors of that farm;
- Some form of energy storage or smoothing to enable the short term power flows to be managed to the 5 minute forecast level.

6.2 Rationale for the changes and our preferred approach

The proposed forecasting standard sets a capability requirement for a connecting generator to deliver predictable and dispatchable supply. This requires a connecting generator to predict in advance the capacity of the plant that can be supplied 'continuously' within each forecast period: firmly for 5 minutes ahead, to a high degree of accuracy for the first 30 minutes and indicatively for 24 hours ahead.

This approach was adopted as:

- It allows for a dispatch system that is scalable for dispatch of up to 100% PV generation to deliver power at any point in time, supporting the achievement of the NT Government's 50% renewable energy target.[30]
- The large volume of PV generation connection applications currently underway and expected to connect prior to sophisticated causer pays mechanisms for system security services and interventions are introduced.
- Stress testing of the technical viability and cost of our proposed forecast obligation by our independent technical experts Entura verified that such forecasting is technically feasible and economically viable and the costs are likely to be lower than alternative options. This was reconfirmed by Entura after review of all submissions to the round 2 consultation process.[31]
- Being an outcome based standard, it allows the connecting generator to achieve this requirement in many different ways including permitting generators to negotiate meeting the connection requirement over multiple connection points by proposing a negotiated equivalent standard via NTC 3.3.5.
- Even though it departs from the NEM practices of AEMO (because the NEM is a much larger electricity market than the NT market, and has a much larger diversity of fuel sources, generation types, and geographical distribution), with increasing penetration of renewables the GPS in the NEM, it is now evolving in directions consistent with our approach, including trialling models of generator self-forecasting being used in central dispatch.

In developing and consulting on the GPS Power and Water developed our problem statement, and then considered various options to address it, including:

[30] Note, Power and Water will still need to address technical system strength and inertia requirements to achieve 100% PV generation output.
[31] Entura's report is attached as Appendix E.

- Having System Control perform the forecasting role equivalent to how AEMO currently operates
- Having battery solutions on the power system (centralised or geographically dispersed)
- Running greater gas-fired spinning reserve or FCAS to manage renewable production volatility
- Using market signals to achieve the required system security outcomes.

We also considered various accuracy requirements and forecasting intervals. We tested the adequacy of these by considering a range of forward looking economic dispatch modelling of the DKIS under scenarios where there are high levels of asynchronous solar penetration to see the dispatch needed for secure operation.

The following sections provide a summary of the problem, options considered and responses to new issues raised in the round 2 consultation.

6.2.1 What problem does this proposed generator obligation seek to address?

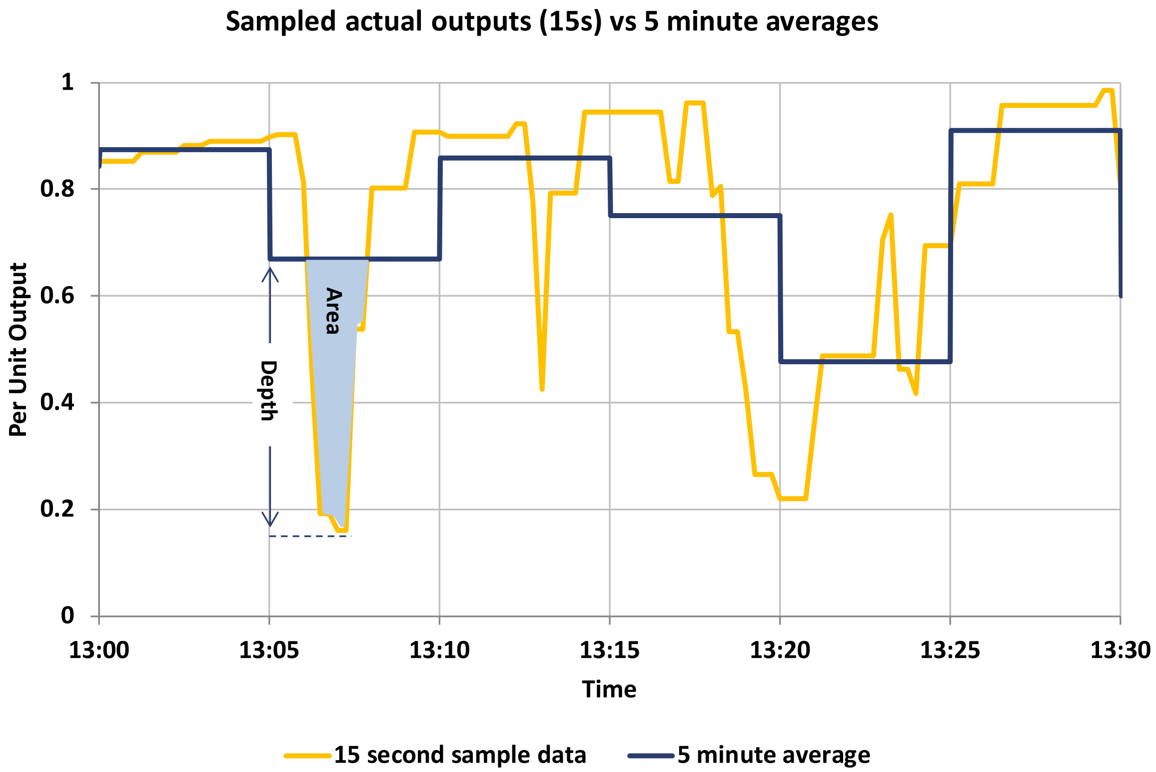
There are two forms of operational power output volatility Power and Water are seeking to manage:

- *Short term output volatility* | Power swings within a 5 minute period, which must be managed by arrangements that are already in-place and operational (such as spinning reserves, battery storage, or other firming arrangements), since this timeframe is too short for additional synchronous generating plant to be brought on line.
- *Medium term output volatility* | Changes slow enough to be included in a pre-dispatch/dispatch process – meaning on a time scale in the order of 30 minutes

Managing short term power output volatility

For example, Figure 6.4 shows the instantaneous (on a 15 second basis) power output (orange line) from an **actual** solar generation facility (in per-unit or 'PU' terms – meaning "1" represents 100% of possible output), compared to the 5 minute average power output (the blue line).

Figure 6.4: Solar output comparison



It can be seen for example that between 1:05pm and 1:10pm the average power generated was around 0.67PU, however after starting at a PU output of 0.9, subsequently for a period of around 2 minutes the instantaneous power was as low as 0.18PU.

To put this in numerical terms, if this were a 100 MW rated PV generator, the power output would have started at 90 MW, and then dropped by about 80 MW (to about 20 MW) over a period of 1 minute, before recovering to around 90 MW by the end of the 5 minute period. This scale of short term power swing (moving from 90% rated output to 20% rated output and back) must be considered in the context of there being around 120 MW of asynchronous PV generators applying for application in the DKIS, and with an expectation of further PV generators making applications.

In addition to large stand-alone PV generators, there is also currently in the order of 50 MW of 'behind the meter' roof-top solar that has already been installed in the DKIS area, with residential and commercial roof-top solar installations expected to continue to increase.

Whilst Power and Water do not have detailed production metering for these roof-top panels (and so cannot clearly identify the exact aggregated scale of the power production swings), it is clear from the wholesale demand observed on the system that similar swings in production are occurring. These kinds of sudden changes have on occasion already challenged the System Controller's ability to maintain the stability of the DKIS, because Power and Water see significant demand 'drop' on or off the system as clouds move through the Darwin area in a period of minutes.

Power and Water is itself now procuring solar forecasting services to provide information on a real time basis about this. However, with no requirement for firming on these roof-top units in the short term, they will present a growing challenge from an overall system control perspective.

The nature of the challenge is further complicated due to the relatively small number of existing gas generators in the DKIS which, for a range of reasons, are experiencing a large number of trip events where a generator has dropped off-line unexpectedly. The Commission reported 98 separate generation trip events during 2017-18.[32] These issues are separately being addressed, but remain an operational reality.

Accordingly, to ensure that consumers are not exposed to load-shedding, System Control plans on the basis of meeting a contingency event where:

1. not only has solar production momentarily dipped (not itself a contingency event);

2. but at that same moment, a generator trip event (a contingency event) occurs.

This can be particularly important in the circumstances where Power and Water are running gas generators specifically to provide support services to the solar production. At these times, if a generator trip occurs there can be relatively little other 'spinning reserve' immediately in the system.

This is currently done by way of the SSG's spinning reserve requirements. Although as Power and Water have noted in this document, these spinning reserve arrangements will rapidly become inadequate as asynchronous solar penetration increases. Hence over time Power and Water are proposing to move to a more sophisticated C-FCAS arrangement. This change is not part of the current GPS arrangements, but has been previously flagged and will be progressed by Power and Water.

Under the proposed GPS arrangements managing the short term power volatility will involve requiring all generators to provide System Control a firm 5 minute **capacity** offer at dispatch time, which is the minimum level of power output that the generator can supply **continuously**[33] during the coming 5 minutes.

Managing medium term power output volatility

System Control can manage power output changes that occur on the timescale of 30 minutes by starting additional generation plant. The existing generation mix in the NT is primarily gas turbine based. Whilst there is some variation, it generally takes approximately 30 minutes to start an NT gas turbine and have it available to contribute to meeting demand. This is the practical minimum when allowing for the time required for human decision making as well as resolving any immediate issues that may occur as a given turbine is started. It should be noted that this is the minimum – it may be insufficient if multiple technical issues occur in the turbine start-up process, which would result in holding insufficient contingency reserves associated increased risk of Under Frequency Load Shedding (UFLS).

In operational terms, System Control must observe multiple timeframes – considering up to a month ahead any known maintenance or other plant outages, and then a day ahead having a proposed set of dispatch arrangements to meet forecast load. The current system operation – and the possible need to start or stop plant - is then closely observed about an hour ahead, with final dispatch

[32] Commission, Northern Territory Power System Performance Review 2017‐18, (June, 2019), p.8.

[33] This is discussed further in the next section, but in summary, 'continuous' here means "at the measuring resolution of the Power and Water systems, nominally SCADA", which is about 15 seconds. So a firm offer of '10MW' given at dispatch time really means "I can generate at least 10MW for every 15 second period over the next 5 minutes". Additionally, high speed data recordings may be used on an ad hoc basis where sampling frequency of SCADA is insufficient.

instructions being made 30 minutes ahead, and any 'starting' issues being finally resolved during that last 30 minutes.

The proposed GPS arrangements are thus intended to be consistent with, and support this timeline, having a requirement for capacity forecasts from all generators on a daily basis, and in particular a rolling-5-minute capacity forecast, with an accuracy requirement being applied for the last 30 minutes ahead of dispatch. It is for this reason that a 90% level of accuracy is proposed over the 30 minute ahead time period. (more on this in section 6.2.6.)

6.2.2 Options considered:

We considered alternative firming options including a centralised battery

The provision of a mandated central battery solution was considered, however Power and Water could not demonstrate that it would be the least cost option. In fact, our modelling indicated that alternate options could be achieved at a lower cost. Additionally, the economics of the various options will change over time as technology develops, thus it is our view that this would also be inconsistent with the *Utilities Commission Act* objectives and regulatory framework with regards to both competitive and fair market conduct and economic efficiency. As such the obligation was structured to allow for a centralised battery solution via the negotiated access provisions for the generator performance standards, but it is at the generator's discretion rather than a mandated service. Should a generator choose to adopt this solution it will be the generator's responsibility to develop the proposal.

The reasons for this approach are:

- It puts the obligation upon those best informed to make the required decisions, which is consistent with the policy objective of driving least cost outcomes as well as technological innovation.
- It places competitive pressure to innovate and improve the forecasting and management of the generation assets.
- It provides a causer pays mechanism, which would otherwise require significant market reform ahead of the new generator connections to ensure that the impact of variable supply is not placed on another user without compensation, which is not deliverable in a practical timeframe.

Our round 2 consultation paper made it clear to stakeholders that the required smoothing did not necessarily need to be provided at each generator, stating that:

> *We intend to set a technical standard for the firmness of offers provided to the market, and not to constrain the manner in which any required smoothing is achieved.*
>
> *For example, a group of generators could engage an outside party to provide firming capability, be that via a centralised battery or providing additional spinning reserve generation, or in some other manner. The proposed solutions would need to be demonstrated through the negotiated connection process.*[34]

[34] Power and Water, *Review of the Northern Territory Generator Performance Standards – Consultation* Paper, June 2019, section 3.7 at page 34

It also explained that our options analysis of onsite (or near-onsite) firming, firming from existing gas turbines, and a centralised battery suggested that the most likely economic response will be at (or near to) the individual asynchronous generation sites. This option analysis is provided in Box 1 below.

Box 1 | Options analysis

Having onsite (or near-onsite) firming | Under this option a PV generator has small on-site batteries for providing firming within 5 minute periods, or other local firming arrangements (possibly shared with other local generators).

This on-site option allows for a relatively small capacity battery on the DC side of the plant, before the existing inverter.

- Based on public information, Power and Water estimate this firming capacity would require around 0.2 MWh of battery for each MW of installed solar.
- No additional network augmentations are required
- No additional inverter is required

Accordingly, Power and Water consider (using public information) this is likely to be the least cost option.

Firming from existing gas turbines | Under this option a PV generator would contract for an existing generator to cover any short term variations

We note however that:

- Existing connected synchronous generators are not designed to accommodate ramps of 10-20 MW over ~1 minute as a regular event, and that is probably the required scale of operation as Power and Water move to having 100 MW + of solar in the DKIS.
- Network stability and transfer limits mean that additional network augmentation is likely to be required, and this will need to be paid for.
- Generation capacity used for this purpose cannot also be counted for system C-FCAS or spinning reserve purposes.

As long as their effectiveness can be demonstrated, there are no barriers to individual parties negotiating these arrangements under NTC 3.3.5 should they wish to do so.

Centralised battery | Under this option a PV generator arranges for a centralised battery owner to inject/absorb from the grid the instantaneous unders/overs of production within the 5 minute period to cover any of these short term variations, in a manner that satisfies System Control.

We note however that:

- A centralised battery for managing these short term variations requires a relatively large inverter (and a relatively small battery), which will be a significant cost due to relative size of storage required for short term variation management.
- Using public data Power and Water estimate the additional costs of doing this service using a centralised battery to be in the order of a 20% premium compared to the 'on site' firming. This additional cost is mostly in the need for a dedicated high-capacity inverter.
- As with using turbines, the centralised approach raises issues of network stability and transfer limits (with the likely result that additional network augmentation would be required).

However as long as their effectiveness can be demonstrated, there are no barriers to individual parties negotiating these arrangements under NTC 3.3.5 should they wish to do so.

6.2.3 Testing that forecasting obligation was technically viable

Testing the technical feasibility and cost effectiveness of PV generators providing capacity forecasts

Our round 2 consultation stepped through how Power and Water had tested technical feasibility and least cost and remains relevant for this submission:

> *On the basis of our review of the data [insolation forecasts from third party providers], we believe that there is no technical barrier to forecasting to the required level of accurate 90% of intervals, and within 5% of power production for the remaining 10% of intervals. We note that within the sample sets we reviewed there was only 1 period that exceeded the error threshold.*
>
> *To manage the transformation from a solar forecast to a capacity forecast is likely to involve using smoothing services from a small amount of battery storage or generation. To verify that this requirement is not overly onerous we have conducted some analysis of the amount of energy storage required to achieve this short term smoothing. Our desktop analysis suggests that on reasonable assumptions such a smoothing requirement could be achieved with in the order of 0.2 MWh of storage capacity for each 1 MW of installed solar capacity (on an assumption of the battery being oversized somewhat to allow for the relatively high instantaneous power flows). This is a relatively small battery, and we anticipate on the basis of our desktop research into pricing would not increase the capital cost of the farm beyond the point of economic viability.* [35]

An independent consultant's review of the proposed standard supports this analysis:

> "Forecasting requirements proposed by PWC have been assessed by Entura for their implications on solar PV generators. Entura supports the view that mature technical solutions are available to meet these requirements. Likely cost (or revenue) implications for generators is estimated in the order of about $320-480/kWac of PV installed or 20-30% of the cost of the solar PV plant, plus a similar ratio of ongoing operations and maintenance cost."[36]

When asked to update their report based on the submissions received the independent consultant maintained the same view:

> "A number of submissions cite limitations in forecasting accuracy as a barrier to the proposed plant output forecasting requirements. Entura understands that these submissions relate to the accuracy of technologies to forecast solar PV output due solely on irradiance variation. Entura's baseline position in its report is that the proposed forecasting requirements can be met through the implementation of energy storage (thus providing sufficient backing for plant output forecasting), and as such are not reliant on irradiance forecasting."[37]

Further stakeholder views after round 2 consultation

Concerns were received in some submissions that the forecasting requirements were not achievable:

> *"Accuracy and Forecasting Requirements Unachievable - Our understanding of the 5% accuracy target was that it achieved a desired level of stability for a given solar penetration based on modelling undertaken. While, the technology of forecasting remains nascent and will improve over time with greater experience and implementation, the physics, technology*

---

[35] Power and Water, *Review of the Northern Territory Generator Performance Standards – Consultation* Paper, June 2019, section 3.4 at page 32

[36] Entura, NT generator performance standards code review - Technical advice, 20 June 2019, section 4, p.7.

[37] Appendix E - APPENDIX E. ENTURA REPORT UPDATE 29 AUGUST 2019

and systems currently available to provide this forecasting accuracy 30 minutes out from dispatch is not available at this time."[38]

If a generator does not have confidence in their chosen solar forecast, backup firming arrangements could be provided for 30 minutes ahead to ensure forecasts were 100% accurate; which would clearly address any technical viability concerns. Although Power and Water's modelling showed this was clearly not required and could be achieved in a more economical manner with a combination of an appropriate sized battery and insolation forecasting.

The availability of technical solutions was further confirmed by Proa Analytics in its round 2 submission, which stated:

Proa Analytics agrees that power systems of the size of the NT would certainly need greater reliability requirements than a system such as the NEM. As solar forecasters, we would not seek to comment on the reliability requirements calculated by PWC, other than to note we believe that commercially available state-of-the art forecasts will substantially assist generators to meet such requirements.[39]

6.2.4 Modelling the required level of forecasting accuracy, and addressing stakeholder questions on compliance and interpretation

Setting the required forecasting accuracy standard

System Control conducted a series of simulations including from 50 MW up to 250 MW of solar generation into the generation mix, and examined the resulting system wide impacts on the levels of spinning reserve required and probabilities of forecasting inaccuracies leading to customer outage events.

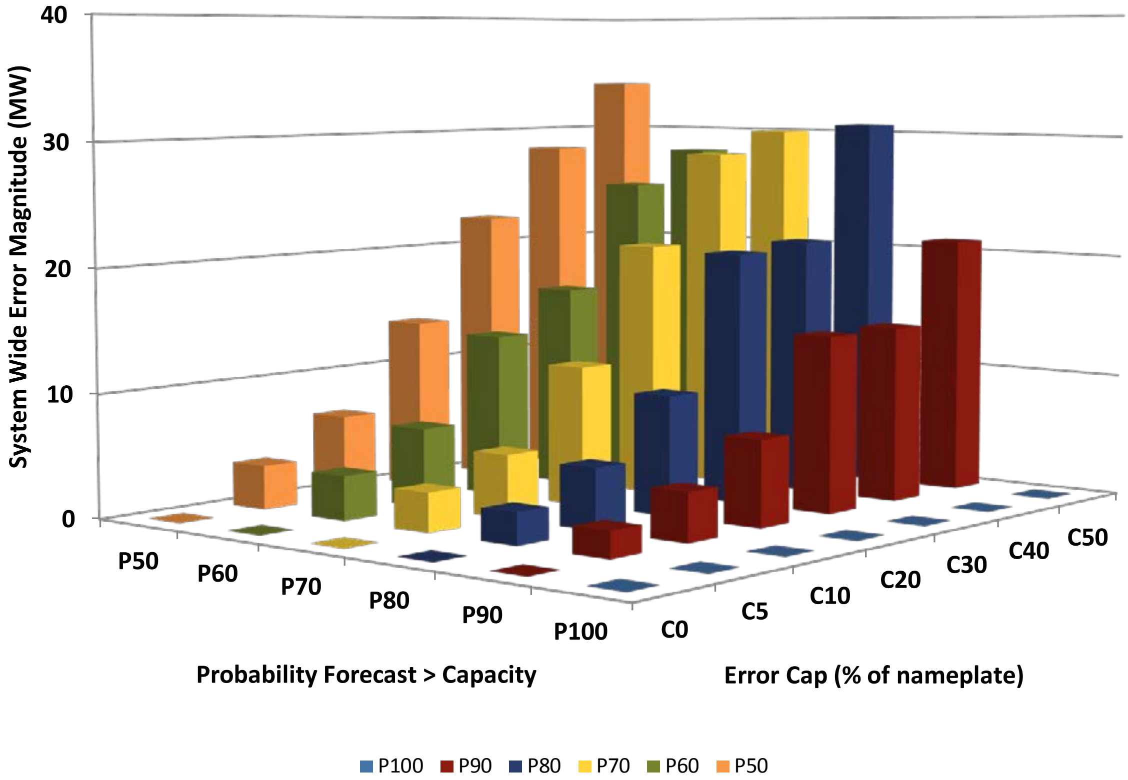
Taking the case considering 120 MW of actual PV generator connection applications, Power and Water found the relationship between the number of daylight 30 minute dispatch periods where the SSG were breached[40], and the accuracy requirement on the solar capacity forecasts to be as shown in Table 2.1: Percentage of Daylight Periods with SSG breach on page 19 above.

The coloured cell in Table 2.1: Percentage of Daylight Periods with SSG breach represents the proposed accuracy standard. It is observed that the number of periods where the SSG are breached due to inaccuracy in provided forecasts increases rapidly as the accuracy requirements are decreased.

A similar message can also be seen from looking at the largest estimated MW error in forecasting that is propagated onto the network at different levels of forecasting accuracy requirement on individual generators. This is presented graphically in Figure 6.5 – where again the proposed accuracy standard is coloured green, and is based on the case of all currently proposed PV generators proceeding (totalling about 120 MW of installed solar capacity)

[38] Submission by Assure Energy dated 19 July 2019, at page 1.
[39] Submission by Proa Analytics dated 18 July 2019, pages 1 and 2.
[40] A breach of the SSG means operation below the minimum level of spinning reserve which increases the risk of customer load shedding following a generator trip contingency event.

Figure 6.5: Forecasting accuracy, worst error



Stakeholders views on the accuracy of the forecasting requirements

Power and Water explained the forecasting requirements and why the accuracy levels were set as proposed in depth in its round 2 consultation paper and stakeholder workshop. It asked for any alternative options that stakeholders considered could meet the system security and *Utilities Commission Act* requirements. We received one proposed alternative:

> *"Tetris suggests that PWC should modify the proposed forecast to 50% probability of exceedance (POE) forecasts, with a pre-determined maximum and minimum bound. Tetris suggests that given the geographical distribution of solar farms, the impact to the Darwin Katherine Interconnected System (DKIS) system from simultaneously incorrect solar forecasts is likely to be minimal. Tetris' approach would utilise leading solar forecasting technologies, removing the need to invest in co-located batteries, which come at considerable cost to solar project for minimal system benefit."*

The modelling undertaken and presented in the round 2 consultation overview paper (replicated above) demonstrates that the increase in system wide error is quite significant when adjusting from P90 to P50. Furthermore, the assertion that this different requirement would be deliverable by insolation forecasts alone without supporting technology does not appear to be reflective of the nature of insolation forecasting providing average power output predictions which is unable to directly address the short term power output volatility issues of solar PV.

The submission from Proa Analytics supports Power and Water's understanding:

> *"We note that even perfect forecasts will not remove the need for such dispatchable compensating technology. To take an example from the GPS Consultation Paper, under the solar generation in figure 3.1 on page 24 (reproduced below), the solar generation varies*

from 90% output to 18% within a five minute period. Even with perfect forecasts the solar farm would need to either curtail generation or use storage to meet the GPS requirements under these conditions."

Stakeholders asked, What happens when there is non-compliance with the forecasting requirements?

Throughout Power and Water's consultation process, stakeholders sought details regarding how capacity forecast accuracy would be measured and if errors exceeded the capacity forecast accuracy requirement how they would be dealt with.

In line with the treatment of other generator non-compliance instances, and consistent with NT NER 5.7.3 (f) (2) Power and Water will proactively work with the generator and may direct the generator to operate at a reduced output in order to manage system security.

The proposed process of managing forecasting non-compliance is broadly outlined below:

1) System Control's dispatch system will include automatic identification of non-compliant forecasts and automatically issue constraints.
    a) This will be a function of the received forecast and errors identified to target the forecasting requirements set out in the NTC if possible.
    b) It is likely that this will be somewhat conservative to minimise risk of a system event as a result of forecasting non-compliance
2) The on shift controller will attempt to communicate with the generator's owner (station operator equivalent) to:
    a) Obtain a preliminary understanding of the likely cause of the non-compliance;
    b) Using the available information from the generator, determine if or how the constraint could be relaxed or removed as appropriate;
    c) If necessary, trigger the generator to commence with the formal outage process with respect to the non-conforming equipment.
3) The formal outage process can apply to a part of plant or a function and involves:
    a) Generator submitting a Generator Outage/Test Request form to system control that identifies the issue (root cause or symptomatic) and investigations, outages or testing required;
    b) System Control assesses the outage and testing requirements.
        i) The ongoing constraints until rectification may be revised here – better information may allow further relaxation of constraint until rectified;
        ii) Testing may require additional security measures;
    c) Rectification and testing undertaken as required;
    d) Generator submits return to service form to system control with results of the investigation, work or testing for approval to recommence normal operation;
    e) System Control reviews the return to service and if approved the constraint is lifted.

Stakeholders asked, How will behind the meter load arrangements be treated?

A topic raised in Power and Water's Round 2 consultation was how loads co-located behind the meter with generators would be treated. We published a response to this after Power and Water's workshop and received a further query on it:

"Following the PWC Responses for Questions Taken on Notice, it is noted that an embedded generator that exports surplus energy to the grid will be able to provide a gross generation forecast and are not required to forecast their load. As such their firm offer for dispatch will

be on the basis of gross supply and not net, that is not taking into account the load. We support this decision.

If Embedded Generators are not exporting to the grid, since only a net load will be visible to the PWC System what are expected to be the dispatching arrangements in this regard (noting an Embedded Generator that is not exporting to the grid can only dispatch up to the total load)?"

Also…..

"If embedded generators are required to forecast generation and comply with dispatch instructions, but can only generate up to the level of site load, there is a high likelihood of significant curtailment. This would be required on a consistent basis to comply with the GPS forecast accuracy requirements and the terms of a non-export connection agreement."

As stated at the workshop, all generators greater than 2 MW even if 'behind the meter' will be required to meet the GPS and as such will be classified as scheduled generators and need to meet capacity forecasting requirements. Dispatch arrangements will be the same regardless of the load. The complexity is introduced in the capacity forecasting where an export limiter is in place.

The forecast will be assessed on the capability of the generating system to continuously deliver active power up to the forecast capacity (gross production capability). As such, if it is under any practical restriction as part of the connection arrangements (such as an export restriction or plant thermal limits) it must be taken into account in the forecast. The assessment of whether an export limit is appropriate would be assessed during the connection process, however Power and Water understand it is unlikely to be adopted by large generators who the GPS would apply to.

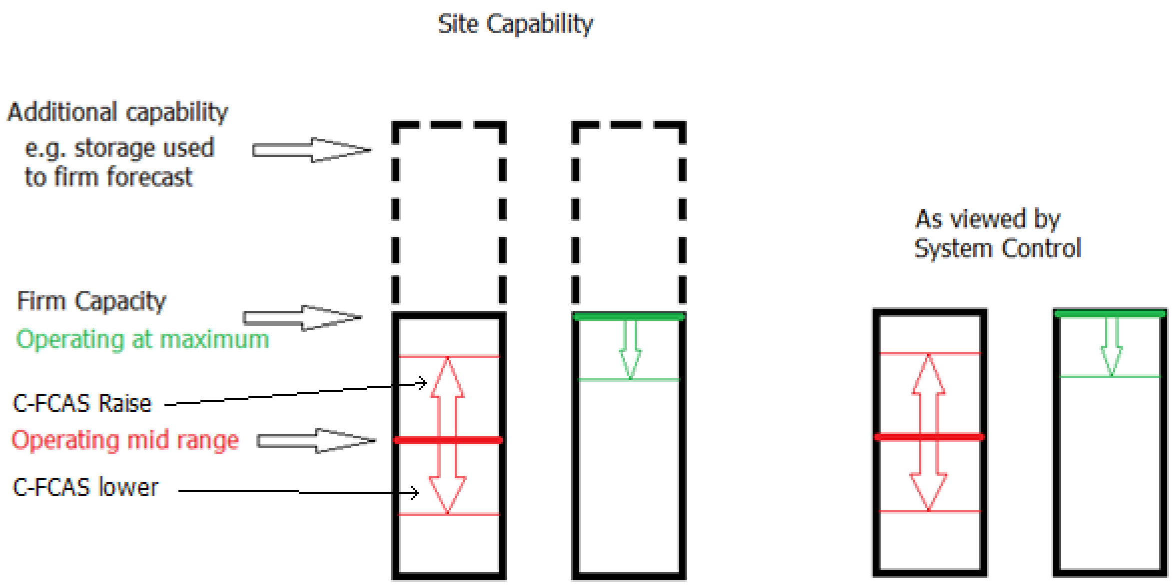
We have clarified C-FCAS and forecasting interactions

C-FCAS capability is required to be delivered subject to energy availability, hence subject to the capacity forecasts. That means that the delivery of C-FCAS can be restricted to maintain the plant within the firm offer/ capacity forecasts and when a site delivers C-FCAS it does not impact capacity forecasts.

The C-FCAS accreditation for each generating system is a function of the operating level of the generating system as a whole and its available capacity at a given point in time. The system controller will thus know from capacity forecasts and dispatch levels what C-FCAS reserves are available at any point in time.

Although a generating system may be comprised of multiple pieces of equipment such as battery and PV inverters, these are expected to provide C-FCAS response within the firm capacity, but not above it. A generating system using a storage device to achieve the capacity forecast obligations should have the appropriate controls in place to ensure excess C-FCAS is not delivered to the detriment of compliance with other NTC provisions including capacity forecasts.

The interaction between C-FCAS and capacity at different levels of firm offer of a generating system is illustrated below.



6.3 We have developed a technology agnostic standard aligned to the *Utilities Commission Act* objectives

The proposed solution aims to:

- promote competitive and fair market conduct;
- prevent misuse of monopoly or market power;
- protect the interests of consumers with respect to reliability and quality of services and supply in regulated industries; and
- promote economic efficiency by placing forecasting risk with the parties best placed to manage it at least total cost.

We achieve this by adopting a standard that does not discriminate between generation technologies and does not prescribe how generators achieve the firming requirements needed for system security.

Stakeholders asked, What infrastructure do I need to meet this requirement?

The proposed GPS does not specify what infrastructure should be used to meet the requirement. There are proven tools and systems to achieve the performance requirement, which Power and Water's independent technical reviewer, Entura, has verified.

The GPS are set to replace the existing generator connection requirements that were written specifically for synchronous generators and were not applicable to new technologies. The proposed code changes deliberately specify the outcome (e.g. capacity forecasts), not the means of delivering that outcome. It is envisaged that this will facilitate technology innovation in a framework that can last longer through this period of rapid technology development.

Stakeholders asked, What arrangements do I need to 'trade' away my firming obligation to another party?

The proposed GPS does not specify how this should be done as Power and Water do not intend to restrict the commercial and technological approaches developed by connecting generators. It is up to the connecting generator to come forward with a proposal that delivers the same outcome for technical assessment by Power and Water. It is worth noting that for a negotiated arrangement, there are many considerations Power and Water may have including but not limited to responsibility of the generator to perform, system security, market arrangements and integration into dispatch systems that will need to be evaluated on receipt of an application.

7. Generator classifications

7.1 Proposed code amendments and their effect

Generator classification proposed amendments can be found in NTC 3.3.5.14. NTC 3.3.5.17, and SCTC 3.2.3 (b).

As per the materiality threshold outlined in 3.3.1 of the NTC, the intent is that all generators 2 MW or larger will be classified as scheduled. Those generators who are smaller than 2 MW will be assessed on a case by case basis and may still be classified as scheduled. As a principle Power and Water are seeking to allow for technological innovation and competition to drive the transformation of the NT power systems, in particular by providing for a consistent set of requirements for major generation plant within the NT industry.

7.2 Rationale for the changes and our preferred approach

Our approach has been driven by the principles and objectives set out in section 2.6 that the Commission is to apply, in particular to:

- promote competitive and fair market conduct;
- prevent misuse of monopoly or market power;
- protect the interests of consumers with respect to reliability and quality of services and supply in regulated industries; and
- Promote economic efficiency by placing risk with the parties best placed to manage it at least cost.

The following sections provide a summary of the problem, options considered and responses to new issues raised in the round 2 consultation. Section 7.3 sets out how the proposed approach achieves the relevant *Utilities Commission Act* objectives.

7.2.1 What problem must the GPS address?

The NT's extremely small power systems will rapidly move to the point where renewable generators represent a majority of the generation producing at certain times. The 'semi-scheduled' status in the NEM reflected the historically 'new entrant' and marginal nature of NEM renewables.[41]

[41] Even so, we note that with the increasing penetration of renewables policy discussions in the NEM are now evolving in directions consistent with the principles underpinning the proposed application here – namely that renewables are moving from the margins into the centre of energy generation, and will be performing the role of the dominant form of energy generation at some time.

It has always been the approach that the application of the NER to the NT would be tailored to the specific conditions that are found here. In the matter of generator classification, this has required recognition that the NEM is a much larger electricity market than the NT market, with a larger diversity of fuel sources, generation types, and geographical distribution.

With the maturing of the renewable industry, and the central role it is being called on to play in meeting the energy demands of the NT power systems, it is not appropriate to maintain this distinction. The distinction only works when asynchronous renewables are not a material share of the generation pool. In effect the 'semi-scheduled' status pushes the risk of generation not performing in the manner forecast to the power system as a whole. This outcome would lead to the costs of addressing this to be borne by those who are not causing it, whereas Power and Water's analysis suggests that generators have access to the least cost ways of addressing it and Power and Water's proposal places the responsibility with them to do so.

7.2.2 We considered if NEM or WEM arrangements would work

The initial stage of Power and Water's consultation process delivered considerable discussion around the potential classifications within the NT electricity sector, with some evidence of an expectation that NER arrangements as applied in the NEM would be applied automatically in the NT.

Our Round 2 consultation paper and workshop examines the issue of fit-for-purpose generator classifications in the NT, including addressing the following questions:

How can PV generators that are inherently intermittent be classified as scheduled?

Capacity forecasting (that is, with a small amount of firming capacity) to the proposed accuracy level 30 minutes ahead provides a sufficient level of predictability for a generator to be classified as dispatchable, based on Power and Water's current modelling.

Is there or should there be a materiality threshold?

It is proposed that the GPS will apply to all generators that are 2 MW or greater. For those generators below 2 MW Power and Water will consider applying a moderated set of technical standards which may give effect to performance that is more akin to semi or non-scheduled. However, this will depend on the relative size of the generator to the system demand in the regulated power system where they are connected.

Round 2 consultation submissions

In response to Power and Water's round 2 consultation paper NT Solar Futures submitted:

> *The semi-scheduled generator classification must be retained to facilitate intermittent renewable energy generation. Definition of semi-scheduled should be similar to the NEM and/or the WEM (intermittent generator). Proposed removal of this classification places an unnecessary cost burden on new intermittent generators entering the market. In both the National Electricity Market (NEM) and the Wholesale Electricity Market (WA) (WEM) there are semi-scheduled and non-scheduled classifications that work well to enable intermittent generation. The removal of the semi-scheduled generator classification will make the NT unattractive for investment due to complexity and cost.*[42]

The connecting generators are significantly different in relative size when compared to the NEM and WEM. For connecting generators of equivalent relative size to the WEM or the NEM minimum

[42] NT Solar Future, July 2019, p.3.

demand, the generator classification would undoubtedly be scheduled, so it is not entirely inconsistent as presented. For example, the equivalent of 30 MW sized generator on the DKIS in comparison to the NEM would be 3,300 MW. Furthermore, the NEM and WEM have markets to manage the intermittency, whereas the NTC GPS provides a framework that allows for appropriate cost allocation and the generator capabilities that would be necessary for operation with 100% of demand supplied by solar PV at some periods of the day.

7.3 Alignment with *Utilities Commission Act* objectives

Consistent with the principles set out in section 2.6 that the Commission will apply, Power and Water consider that this approach:

- ensures that there is a consistent incentive across all forms of generation and thereby promotes competitive and fair market conduct;
- promotes economic efficiency by supporting the lowest total cost of reliably and securely providing energy whilst facilitating the connection of asynchronous renewable energy technologies because it ensures the system security risk associated with increasing levels of asynchronous generation is placed with those best able to manage it;
- protects the interests of consumers with respect to reliability and quality of services and supply by:

- maintaining the system security levers of predictability and dispatchability that System Control needs to perform its function; and
- learning from the lessons currently being experienced in the NEM.

8. Requiring the ability to have inertia and/or C-FCAS capability

8.1 Proposed code amendments and their effect

Proponents of new generating systems will be required to connect in accordance with the proposed NTC clause 3.3.5.15 'Inertia and Contingency FCAS'. Although the GPS specifies that to meet the automatic standard the performance is to be achieved at the point of connection, it does not prohibit that the proponent may negotiate for the standard to apply across more than one connection point if it benefits the system.

This would be through the process outlined in the proposed NTC clause 3.3.5 on the basis that the connecting generator retains responsibility at all times.

The NTC clause 3.3.5.15 requires that a generator is *capable* of supplying both C-FCAS raise and lower (subject to control mode and dispatch level), the NTC contains no obligations with regards to *enablement, provision* or *delivery* of C-FCAS. C-FCAS lower refers to the service where a generator reduces output in response to high frequency. C-FCAS raise refers to the service where a generator raises output in response to low frequency. The italicised terms are defined in Box 2.

However, during the connection process, the various performance requirements (including C-FCAS) would require testing to demonstrate capability by actually delivering the service; this does not influence the normal mode of operation for the generating system following the connection process.

Although batteries and other technical solutions may be used, an inverter with a droop frequency control could also meet this capability requirement. The incremental cost for an inverter based generator to obtain this capability by droop frequency control is minor.

An independent consultant's review of the proposed standard supports this analysis:

> *"This definition is consistent with Entura's view of the capability of typical inverter based solar PV plant. System Control could only call on raise capacity from systems with no storage if they were known to already be curtailed. A requirement for 'enablement' of automatic frequency control is expected to add no significant additional cost to a typical inverter solution in the market now."* [43]

Box 2. Our terminology

To ensure adequate distinction between connection requirements and operational requirements such that the matters discussed in this document are clear and unambiguous, the following terms relating to C-FCAS are defined:

- *Capability* | Connection requirement (NTC): Connecting parties are to demonstrate that plant can supply C-FCAS services if the generator is in the appropriate control mode to do this and with appropriate headroom/floorroom. It does not specify a generator will be obligated to operate in this mode or curtailed to ensure provision.
- *Enablement* | Operational requirement (SCTC): If the System Controller requires a generator to be enabled for C-FCAS it will only supply it if it has the headroom (for raise) or floorroom (for lower) to do so. A generator operating at maximum output can be enabled for C-FCAS, but be unable to supply C-FCAS raise as it has no headroom. In regards to lower service, a generator can provide C-FCAS lower if it is enabled and it is dispatched above its minimum stable load.
- *Provision* | Operational requirement (SCTC): If the System Controller requires a generator to be enabled for C-FCAS services AND its dispatch level has the headroom or floorroom to supply the C-FCAS service it is providing C-FCAS. For example, a generator dispatched below maximum capability that is enabled for C-FCAS is able to provide a C-FCAS raise service. This service is the quantity referred to in any market payment arrangements.
- *Delivery* | Operation is the result of provision when a service is used. For instance if a generator tripped, other generators providing C-FCAS raise would then deliver this service by increasing their output in response to the low system frequency.

8.1.1 Use of C-FCAS

The initial feedback received on the proposed C-FCAS requirements suggested to us further clarification was required about the intended difference between all generators:

1. having the technical capability of providing C-FCAS, as compared to
2. being called upon to actually provide this service.

Under the current commercial arrangements in the NT (the I-NTEM) there is no mechanism to facilitate ancillary service payments to generators other than TGen.

The I-NTEM was designed as a fit for purpose short-term market arrangement on the principle of TGen being the primary provider of ancillary services. System Control have managed the system utilising

[43] See Appendix C, section 3.1, Page 6.

these principles for the past four years, and accordingly it would be an unusual situation where System Control actually constrained down a non-TGen generator to provide C-FCAS raise. In the I-NTEM, Power and Water will continue to operate all generators with C-FCAS enabled, with the provision of C-FCAS based on the principles of:

- security constrained economic dispatch; and
- in normal situations, any C-FCAS provision from non-TGen generators results in their dispatch being equal to or higher than it would otherwise be.

How do we operate C-FCAS lower?

Generators will operate in a frequency droop mode (C-FCAS enabled). This means whenever a generator is dispatched above its minimum stable loads it provides C-FCAS lower. This is beneficial for generators to do as it avoids displacement (curtailment/constrained off) by TGen plant that would be required to operate with sufficient 'floor room' necessary to perform this service.

How do we operate C-FCAS raise?

Under the auspices of security constrained economic dispatch, when a generating system is offered in at a lower price for energy it will be dispatched in preference to higher cost generating system subject to security requirements. Operation in this way will mean lowest cost facilities (e.g. solar) will have no 'headroom' and therefore will be unable to provide C-FCAS raise. This is expected to be the most common situation and mean under normal circumstances, TGen will be the primary provider of C-FCAS raise.

Situations where TGen facilities may not have sufficient headroom will require low cost facilities to be constrained below output to leave headroom. Alternatively situations such as islanding may arise where there is insufficient demand to allocate headroom to generating systems owned by TGen after using more efficient energy sources. To use these more efficient energy sources, these generating systems such as solar PV must be providing C-FCAS Raise or be constrained further to allocate load to TGen generating units so they could provide the service. It is clearly more desirable to dispatch the lowest cost sources of energy in preference; hence under these circumstances it will be efficient that these generators provide C-FCAS Raise. Note that in these circumstances, some load may be required to be allocated to synchronous generation for inertia purposes.

8.2 Rationale for the changes and our preferred approach

The following sections provide a summary of the problem, options considered and responses to new issues raised in the round 2 consultation.

8.2.1 What problem must the GPS address?

Without all generators being C-FCAS capable, Power and Water cannot effectively manage frequency control under all possible operating conditions and dispatch scenarios, whilst facilitating high levels of PV generation dispatch. The principle behind the proposed GPS clause on C-FCAS is to 'do no harm' in regards to reducing the power system's technical capability to maintain power system frequency by ensuring a sufficient level of services being available to be dispatched.

Renewable plant having the technical capability to provide FCAS is a required step to enable the power system to support a significant penetration of PV generation.

As discussed earlier in this consultation paper, the level of new generation coming into the NT power system means that over coming years asynchronous solar generation will at certain times be the dominant form of generation. Clearly as the NT sector evolves so will the manner in which FCAS is provided.

8.2.2 What are the key benefits?

We have for example discussed in previous sections that the SSG, which currently work mostly on the basis of minimum spinning reserve requirements at Channel Island, will need to be replaced by an FCAS based contingency regime, and having the dominant generators operating at that time as participants will clearly be required.

The requirements outlined in the GPS are intended to:

- 'Future proof' the equipment installed by ensuring that the underlying capabilities to (at least potentially) participate in future (as yet unspecified) commercial arrangements exists.
- Ensure that the system is capable of being operated safely even in circumstances where TGen's ability to provide FCAS has been constrained in some manner.
- Ensure that new entrants are not required to be constrained down pre-emptively in order to ensure that TGen plant is operating with sufficient 'floor room' to provide C-FCAS lower. We consider on a practical basis that this is the major factor that should actually be encouraging all participants to ensure they are FCAS capable.

It is Power and Water's expectation that the proposed connection requirement can be met with minimal cost, since most inverters on the market have the required capabilities

Only under abnormal circumstances, such as islanding where TGen are unable to provide adequate C-FCAS raise is it expected that non TGen generators may be dispatched at a level such that they provide C-FCAS raise, the less desirable alternative is to not dispatch these (or significantly constrain) asynchronous generation sources. We are not able to provide guidance at this time as to the likely frequency of these events, since it is at least in part determined by the exact location and timing of connections of new generation to the grid. We will be conducting further modelling on this question of the likely practical number of events as asynchronous generation rises.

8.2.3 The AEMC ruled against similar requirements proposed for the NER, what is different here?

The expected rapid high penetration of asynchronous generation in the NT, and the sizing of NT generators being extremely large relative to the system demand (compared with their counterparts in the NEM), mean Power and Water face both large contingency sizes and lower inertial frequency response.

Thus these provisions for C-FCAS capability are of critical importance in the NT power systems, which due to generation characteristics already operate with low levels of frequency control.

The large size of units compared to the system means that if significant generation is dispatched without frequency control enabled, in the event of a contingency it would not respond to the frequency and would maintain existing loading levels. This significant quantity of energy would be held by these generators until a dispatch signal is received, which takes minutes to manage loading levels on generators, far too slow in an emergency event.

In this case it is possible (and has occurred in the past) that following a contingency event and under frequency load shedding (UFLS), the remaining TGen units online would not have sufficient loading levels to operate in a stable manner. They would thus try to increase their loading level by pushing the system frequency up. With the generators operating with C-FCAS disabled, the frequency could go out of bounds in the high range which would likely result in cascading failure and complete loss of supply to all customers (i.e. a System Black event). This is a much more credible scenario in the NT than it is in the NEM, which necessitates a different approach.

In the scenario described above, the normal C-FCAS arrangements were insufficient to accommodate the contingency event. The desirable outcome from new generators is that they have C-FCAS capability and operate with C-FCAS enabled to provide C-FCAS lower when operated at maximum output, such that they can share loading with the synchronous generators following operation of UFLS to dampen the unstable frequency oscillations, that could otherwise cause a system black.

8.2.4 Enabling this mode is in a generator's self-interest anyway

Although enabling C-FCAS lower will result in the normal provision of C-FCAS lower from non-TGen generators, in practice it allows greater dispatch levels for these generators that would have been achieved if they were not delivering C-FCAS lower.

Under normal circumstances, the only impact to energy production for these generators is following a load contingency; these generators will have delivered C-FCAS lower by temporarily (typically less than 15 minutes) reducing their output, but overall have been dispatched at a greater quantity for a longer period of time.[44] The reliance on new generators to provide contingency lower service will increase significantly as the share of energy available to TGen reduces due to this service requiring the generators have a share of energy reduce on demand.

During stormy periods, the contingency lower requirement is approximately 30% of system demand,[45] so constraint levels could be significant if C-FCAS is not enabled and provided.

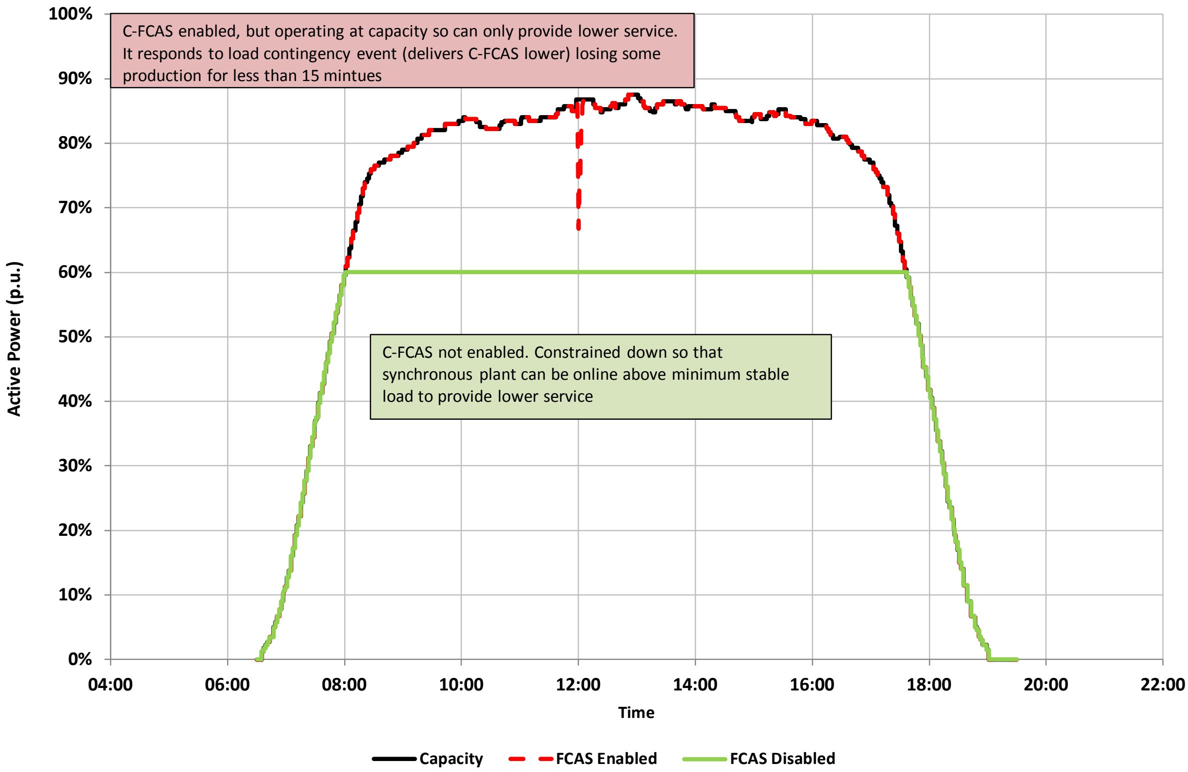
If this service is not provided by these generators, they will with increasing frequency be constrained down to allow a TGen unit online (with sufficient floorroom) to provide FCAS lower services as new generators increase their market share.

Figure 5.1 below shows an example of the difference between a generator enabled and providing C-FCAS lower or not, in the circumstance where it would be constrained to allow another unit to perform this service.

[44] The greater quantity of dispatch is due to the likelihood of being constrained down or offline to facilitate energy dispatch on T-Gen units to have those units providing C-FCAS lower

[45] This is due to load relief following a lightning caused voltage surge. The load relief is understood to be from power electronic devices 'protecting' themselves from unstable voltages.

Figure 8.1: Comparison of dispatch options



An emergency scenario raised in the previous section that requires C-FCAS lower provision for all generators is during an UFLS event generators must share load to stabilise the system. The outcome of not providing C-FCAS lower is high risk of a system black event due to cascading failure with insufficient stabilising load on synchronous plant. The primary benefactor of this is the customers' continued supply, although another benefit is the temporary reduction in load from providing C-FCAS lower would naturally be less impactful to these generators than the impact to production when restoring from a system black.

8.2.5Transition to competitive market sourcing of C-FCAS

It is anticipated that as the I-NTEM is reformed to adopt competitive ancillary service mechanisms, that compensation for the provision of these services will be available. Although this is anticipated and will change how C-FCAS is used into the future, the proposed approach is expected to provide least cost outcomes in both the short to medium term as well as over the life of the generator. This is due to a combination of the immaterial cost of being capable of providing this service and the self-interest of providing the service under the current I-NTEM arrangements. Power and Water is working with DTF to transition to NTEM as fast as possible such that the value of ancillary service providers addressed by quid pro quo in the I-NTEM can be directly recognised.

8.3 Alignment with *Utilities Commission Act* objectives

The proposed solution aims to:

- protect the interests of consumers with respect to reliability and quality of services and supply in regulated industries; and
- promote economic efficiency by enshrining the causer pays principle.

POWER NETWORKS

NETWORK TECHNICAL CODE
and
NETWORK PLANNING CRITERIA

Version ~~3.~~4~~1~~

~~December 2018~~8~~3~~September 2019

[THIS VERSION IS MARKED UP AS AT 29 AUGUST 2019 TO SHOW PROPOSED CHANGES.

FOLLOWING APPROVAL AND BEFORE PUBLICATION, THE DOCUMENT WILL BE REFORMATTED AND REPAGINATED IN CURRENT TEMPLATES]

Table of Contents

Introduction

Transmission and *distribution network*s owned by *Power and Water* cover the major centres of the Northern Territory. The ~~legislated Third Party Access regime~~*NT NER* gives rights to private *Generator*s and *load customer*s to use the *network*s to enable contracted trade between *Generator Users* and *Customer Users*.

Structure of this document

This document comprises the following parts:

Part A The legislative requirements that apply to *Power and Water Network*s and to *customer*s seeking access to its regulated electrical *network*s.

Part B The ***Network Technical Code*** sets out technical requirements designed to ensure that the *network* and the *customer* installations and equipment *connect*ed to the *network* may be operated and maintained in a secure and *reliable* manner.

Part C The ***Network Planning Criteria*** are designed to ensure that new *load*s and *Generator*s *connect*ed to the *network* do not compromise the security and *reliability* of *supply* to all *Network Users*.

Part D Attachments, including, amongst other things, a Glossary of terms and Schedules of the information that is required to be provided by *customer*s seeking to *connect* to *Power and Water's* regulated *network*s.

The *Network Technical Code* and *Network Planning Criteria* apply to *Power and Water's* regulated *network*s.

Document nomenclature

Terms defined in the Glossary of this document are *italicised*.

Explanatory and contextual material is included in boxed sections that do not form part of the *Network Technical Code* or *Network Planning Criteria*.

Document amendment

This document is subject to amendment in accordance with the legislative provisions and users of the document are advised to obtain the current version from the Manager Regulation, Pricing and Economic Analysis, at the following address:

Power and Water Corporation
Level 7, Mitchell Centre, Darwin NT 0800
GPO Box 1921. Darwin NT 0801
Telephone: (08) 8985 8431
Facsimile: (08) 8923 9527

The document is also available from *Power and Water's* Internet site at the following address: http://www.powerwater.com.au/.

Part A Legislative requirements

This document is prepared pursuant to the Northern Territory *Electricity Reform (Administration) Regulations*, as in force at 1 July 2019, which require Power and Water as a network provider to publish a Network Technical Code.

~~This document is prepared pursuant to the Northern Territory *Electricity Networks (Third Party Access) Act* (TPA Act), as in force at 1 August 2012.~~

~~The Northern Territory Electricity Networks (Third Party Access) Code (Network Access Code) is established in Part 2 of the TPA Act and the accompanying Schedule. The Network Access Code sets out:~~

~~(a) The terms and conditions under which access to an *electricity network* is to be granted to third party *Users* and the associated obligations both on the *network* provider and on *network Users*;~~

~~(b) The framework within which *Access Agreements* are to be negotiated and implemented; and~~

~~(c) The mechanism for resolving access disputes.~~

~~Clause 9, sub clause (2) of the Network Access Code requires the *network* provider to prepare and make publicly available a *Network Technical Code* and *Network Planning Criteria*.~~

~~Clause 30, sub clause (2) of the Network Access Code states that all *network Users* shall comply with the *Network Technical Code* regarding *connection* to and use of the *electricity network*.~~

Network Technical Code

Regulation 25(4) of the *Electricity Reform (Administration) Regulations* states that the Network Technical Code must cover the requirements set out in Schedule 2, other than:

(a) matters dealt with in the National Electricity (NT) Rules; or

(b) matters appropriately dealt with in the System Control Technical Code.

~~Schedule 1, clause 1 of the Network Access Code lists the requirements of the *Network Technical Code*. This *Network Technical Code* sets out the following matters. The relevant clauses of this document are also referenced in~~ Figure Figure 1~~able 1~~ sets out the matters listed in Schedule 2, together with their location in this Code or other instrument.~~.~~

Figure~~Table~~ 1~~1~~ – Requirements of the *Network Technical Code*

Code requirement	clause
(a) performance standards in respect of service quality parameters in relation to the electricity network	2
(b) the technical requirements that apply to the design or operation of plant or equipment connected to the electricity	3

Code requirement		clause
	network	
(c)	requirements relating to the operation of the electricity network (including the operation of the network in emergency situations)	4
(d)	obligations to test plant or equipment in order to demonstrate compliance with the Network Technical Code	5.1
(e)	procedures that apply if the network provider believes that an item of plant or equipment does not comply with the requirements of the Network Technical Code	5.6
(f)	requirements relating to the inspection of plant or equipment connected to the electricity network	5.7
(g)	requirements that relate to control and protection settings for plant or equipment connected to the electricity network	6
(h)	procedures that apply in the case of commissioning and testing of new plant or equipment connected to the electricity network	7
(i)	~~aside from matters appropriately dealt with in the *System Control Technical Code*,~~ procedures that apply to the disconnection and reconnection of plant or equipment from the electricity network	8
(j)	~~aside from matters appropriately dealt with in the *System Control Technical Code*,~~ procedures relating to the operation of generating units connected to the electricity network (including the giving of dispatch instructions and compliance with those instructions)	9
(k)	*metering* requirements in relation to *connections*	~~10~~NT NER Chapter 7A
(l)	the information required to be provided to the Network Operator in relation to the operation of plant or equipment connected to the electricity network at a connection and how and when that information is to be provided.	11

Network Planning Criteria

Schedule ~~1~~2~~, clause 2~~ of the ~~Network Access Code~~ *Electricity Reform (Administration) Regulations* requires that the *Network Planning Criteria* must be consistent with the Network Technical Code, and lists the matters that shall be contained in the *Network Planning Criteria*. The relevant clauses of this document are referenced in Figure 2~~Table 2~~.

Figure 2 – Requirements of the *Network Planning Criteria*

Planning criterion	clause
(a) contingency criteria;	14.6
(b) steady-state criteria including:	15
(i) voltage limits;	15.2
(ii) thermal rating criteria; and	15.3
(iii) fault rating criteria;	15.4
(c) stability criteria including:	16
(i) transient stability criteria; and	16.1
(ii) voltage stability criteria;	16.2
(d) quality of supply criteria including:	17
(i) voltage fluctuation criteria;	17.1
(ii) harmonic voltage criteria;	17.2
(iii) harmonic current criteria;	17.2
(iv) voltage unbalance criteria; and	17.3
(v) electro-magnetic interference criteria;	17.4
(e) construction standards criteria; and	18
(f) environmental criteria.	19

Part B - *Network Technical Code*

1 Application

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

1.1 Persons to whom the *Code* applies

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

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

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

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

1.2 *Plant* and equipment to which the *Code* applies

(a) Equipment installed in the *Network Operator's electricity network*s; and

(b) Equipment installed by *Users* who are *connect*ed (either directly or indirectly) to the *electricity network*s.

1.3 Other documents

(a) This *Code* and the Network Planning Criteria at Part C shall be read in conjunction with the following *Power and Water Corporation* documents:

(1) Service Rules;

(2) Installation Rules;

(3) Metering Manual;

(4) Network Policies and Safe Working Procedures; and

(5) *System Control Technical Code*.

1.4 Commencement

(a) Version 1 of the *Code* came into operation on 1 April 2000 (*"Code commencement date"*).

(b) Amendment 2.0 of the *Code* was entitled the Network Connection Technical Code and was issued in April 2003.

(c) ~~This Version~~Amendment 3.1 ~~amendment~~ of the *Network Technical Code* and *Network Planning Criteria* ~~has been made in accordance with legislative provisions and~~ took ~~akes~~ effect from December 2013.

~~(c)~~(d) This amendment [XX] of the *Network Technical Code* and *Network Planning Criteria* has been made in accordance with the legislative provisions and takes effect from [insert].

1.5 Interpretation

(a) 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.

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

1.5.1 Conflict between *Technical Codes*

(a) A conflict exists when there is a difference in substance or interpretation of the provisions contained in the *Network Technical Code* and provisions contained in the *System Control Technical Code* relating to *power system*:

(1) *reliability*;

(2) safety;

(3) security;

(4) operational issues; or

(5) procedures.

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

(c) Where a conflict cannot be resolved under sub clause (b), consultations will take place between:

(1) the *Power System Controller*;

(2) the *Network Operator*; and

(3) any affected *Users*.

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

1.6 Dispute resolution

(a) Should a dispute arise between a *User* and the *Network Operator* concerning this *Code*, the *Network Operator* shall negotiate with the *User* to determine mutually acceptable agreed outcomes.

(b) If an agreement cannot be reached between these two parties, the Utilities Commissioner shall arbitrate the dispute.

1.7 Obligations

1.7.1 Obligations of the *Network Operator*

(a) The *Network Operator* shall comply with the *power system* performance and *quality of supply* standards:

(1) described in this *Code*; and

(2) in accordance with any ~~*Access Agreement*~~*connection agreement* with a *User*.

(b) The *Network Operator* shall:

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

(2) permit and participate in inspection and testing of facilities and equipment in accordance with clause 5.1;

(3) permit and participate in commissioning of facilities and equipment which is to be *connect*ed to its *network* in accordance with clause 7;

(4) advise a *User* with whom there is a~~n~~ ~~*Access Agreement*~~*connection 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 5.5 where there are reasonable grounds to question the validity of data.

(c) The *Network Operator* shall arrange for:

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

(2) management, maintenance and operation of its *network* to minimise the number of interruptions to *agreed capability* at a *connection point* on or with that *network* by using *good electricity industry practice*; and

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

1.7.2 Obligations of *Users*

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

(1) relevant laws;

(2) the requirements of this *Code*; and

(3) *good electricity industry practice* and applicable *Australian Standards*.

(b) Each *User* shall:

(1) comply with the reasonable requirements of the *Network Operator* in respect of design requirements of equipment proposed to be *connect*ed to the *network* of the *Network Operator* in accordance with clause 3;

(2) permit and participate in inspection and testing of facilities and equipment in accordance with clause 5.1;

(3) permit and participate in commissioning of facilities and equipment which is to be *connect*ed to a *network* location for the first *time* in accordance with clause 7;

(4) operate facilities and equipment in accordance with any reasonable *direction* given by the *Network Operator* and *Power System Controller*; and

(5) give notice of intended voluntary *disconnection* in accordance with clause 8.

1.7.3 Obligations of *Generator User*s

(a) A *Generator User* shall comply at all times with applicable requirements and conditions of *connection* for ~~*Generation Units*~~*generating units*:

(1) as set out in clause~~s 3.2 and~~3.3; and

(2) in accordance with any ~~*Access Agreement*~~*connection agreement* with the *Network Operator*.

1.7.4 Obligations of *Generator Users* with small *generating systems* ~~*Small Generators*~~

(a) A *Generator User* with a *Small Generator* shall comply at all times with applicable requirements and conditions of *connection* for a small *generating systems*~~Small *Generation Units*~~:

(1) as set out in clauses 3.2 and 3.4; and

(2) in accordance with any ~~*Access Agreement*~~*connection agreement* with the *Network Operator*.

1.7.5 Obligations of *Users* with *Small Inverter Energy Systems*

(a) A *User* with a *Small Inverter Energy System* shall comply at all times with applicable requirements and conditions of *connection* for *Small Inverter Energy Systems*:

(1) as set out in clauses 3.2 and 3.5; and

(2) in accordance with any ~~*Access Agreement*~~*connection agreement* with

the *Network Operator*.

1.7.6 Obligations of *Users* with *loads*

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

(1) as set out in clauses 3.2 and 3.6; and

(2) in accordance with any ~~*Access Agreement*~~*connection agreement* with the *Network Operator*.

1.8 Variations and exemptions from the *Code*

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

(1) the requirements may be varied, but only with the agreement of the *Network Operator*;

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

(3) unless otherwise agreed; and

(4) except where specifically varied in a~~n~~ ~~*Access Agreement*~~*connection agreement*.

(b) In all cases the *Network Operator* will notify in writing any such variation or exemption to *Users*.

1.9 Amendments to the *Code*

(a) Any ~~*System Participant*~~*User* may propose an amendment to the *Code*.

(b) A proposal to amend the *Code* shall be made in writing by the ~~*System Participant*~~*User* to the *Network Operator* and shall be accompanied by:

(1) the reasons for the proposed amendment to the *Code*; and

(2) an explanation of the effect on ~~*System Participants*~~*Users* of the proposed amendment to the *Code*.

(c) Subject to paragraph (f) below, t~~T~~he *Network Operator* shall review the proposed amendment to the *Code* and within 30 days advise the ~~*System Participant*~~*User* or electricity entity:

(1) whether the proposed amendment to the *Code* is accepted or rejected; and

(2) the reasons for the acceptance or rejection of the proposed amendment to the *Code*.

(d) The 30 day period in clause 1.9(c) is extended as reasonably required to allow any public consultation or consultation with the Utilities Commission required under the legislative provisions.

~~(d)~~(e) The *Network Operator* shall review the operation of the *Code* at intervals of no more than 5 years and may seek submissions from ~~*System Participants*~~*Users* and the Utilities Commission during the course of the review.

~~(e)~~(f) Before amending the *Code* or *Network Planning Criteria* in a material way, the *Network Operator* must consult the Utilities Commission and undertake consultation in accordance with the legislative provisions.

2 *Network* performance standards

2.1 Introduction

This clause 2 describes the technical performance parameters and standards for the *power system*. These standards provide the basis for the technical requirements for equipment *connect*ed to the *electricity network*, covered in clause 3.

2.2 *Power system* operating *frequency*

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

(b) The accumulated synchronous *time* error shall be less than 15 seconds for 99% of the *time*.

2.2.1 *Frequency* range under normal operating conditions

(a) The *frequency* ranges under normal operating conditions for the Northern Territory *regulated network*s are set out in Figure 3~~Table 3~~.

Figure 3 – *Frequency* range under normal operating conditions

***Power and Water* system**	***Frequency* range**
Darwin – Katherine	50 Hz ± 0.2 Hz
Alice Springs	50 Hz ± 0.2 Hz
Tennant Creek and isolated, *regional distribution network*s	50 Hz ± 0.4 Hz

2.2.2 *Frequency* range under abnormal operating conditions

(a) To cover for the loss of a ~~*Generation Unit*~~ *generating unit* *from* the *power system* two measures will be applied to arrest the fall in *frequency* following the loss of ~~*Generation*~~ *generation* and to return the *frequency* to within normal operating levels as specified in clause 2.2.1:

(1) utilisation of available *spinning reserve* or C-FCAS as applicable in each regulated power system, under the *direction* of the *Power System Controller*; and

(2) *disconnection* of system *load* manually or by means of automatic *protection*.

(b) Under abnormal operating conditions, the *network frequency* may vary between 47 Hz and 52 Hz.

(c) In the case of operation below 47 Hz but at or above 45 Hz, all *generating units* ~~*Generation Units*~~ shall remain *connect*ed to the *Network Operator's network* for a period of at least 2 seconds.

(d) With sustained operation below 47 Hz, *under frequency load shedding* schemes may *disconnect load* on the *network* to restore *frequency* to the normal operating range, in accordance with clause 3.2.8.1.

(e) *Frequency* stability shall be satisfied under all credible *power system load* and *generation* patterns, and the most severe credible contingencies of *transmission plant* including the loss of *interconnect*ing *plant* leading to the formation of islands within the *power system*.

(f) Each island in the *power system* that contains *generation* shall have sufficient *load shedding* facilities in accordance with clause 16 of the *Network Planning Criteria* to aid recovery of *frequency* to the range 49.5 Hz to 50.5 Hz in the *network*.

(g) When islanding occurs the *Power System Controller* will determine which *power station* or *generating unit* ~~*Generation Units*~~ in each isolated system will regulate the *frequency* in that system.

2.3 Power *frequency voltage* levels

2.3.1 Steady state *voltage* levels

(a) The requirements for steady-state *voltage* levels are set out in clause 15.2 of the *Network Planning Criteria*.

(b) The specifications for *voltage* levels in clause 15.2 shall apply in this Code.

(c) *Users'* equipment shall be designed to withstand these *voltage* levels.

(d) The power *frequency voltage* may vary outside the ranges set out in this clause 2.3.1 as a result of a *non-credible contingency event*.

2.3.2 Temporary over-*voltage*s

(a) As a consequence of a *credible contingency event*, the *voltage* of *supply* at a *connection point* shall not rise above its normal *voltage* by more than the percentage specified in clause 17.1.1 of the *Network Planning Criteria*.

(b) *Users'* equipment shall also be designed to withstand these *voltage* levels.

(c) As a consequence of a *contingency event*, the *voltage* of *supply* at a *connection point* could fall to zero for any period.

2.3.3 Step *change*s in *voltage* levels

Step *change*s in the *power system voltage* levels may take place due to switching operations on the *network*. The step *change*s in *voltage* shall not exceed the limits set out in clause 17.1.2 of the *Network Planning Criteria*.

2.4 *Quality of supply*

2.4.1 *Voltage* fluctuations

A *voltage* disturbance is where the *voltage* shape is maintained but the *voltage* magnitude varies and may fall outside the steady state *supply voltage* range set out in clause 15.2 of the *Network Planning Criteria*. Short duration *voltage* disturbances of durations of up to one minute are termed *voltage* sags and swells.

The ENA publication Customer Guide to Electricity *Supply* contains information on the typical *voltage* sags experienced on Australian *electricity network*s and how *customer*s can mitigate the risks of equipment maloperation because of sags.

Rapid *voltage* fluctuations cause *change*s to the luminance of lamps, which can create the visual phenomenon termed flicker.

(a) Under normal operating conditions, fluctuations in *voltage* on the *network* should be less than the "compatibility levels" defined in Table 1 of *Australian Standard* AS/NZS 61000.3.7 (2001).

(b) To facilitate the application of this standard *Power and Water* shall establish "planning levels" for its *network*s, as provided for in the *Australian Standard*.

2.4.2 Harmonic distortion

2.4.2.1 Harmonic *voltage* distortion

(a) Under normal operating conditions, the harmonic *voltage* in the *network* shall be less than the "compatibility levels" defined in Table 1 of *Australian Standard* AS/NZS 61000.3.6 (2001).

(b) To facilitate the application of this standard *Power and Water* shall establish "planning levels" of harmonic distortion for its *network*s as provided for in the *Australian Standard*.

(c) Planning levels for harmonic *voltage* distortion are specified in clause 17 of the *Network Planning Criteria*.

2.4.2.2 Non-integer harmonic distortion

Inter-harmonic or non-integer harmonic distortion may arise from large converters or power electronics equipment with Pulse Width Modulation (PWM) converters interfacing with the *power system*.

(a) Under normal operating conditions, the emission levels for inter-harmonic *voltage* in the *network* shall be less than the levels defined in section 9 of *Australian Standard* AS/NZS 61000.3.6 (2001).

(b) To facilitate the application of this standard *Power and Water* shall establish "planning levels" of inter-harmonic distortion for its *network*s as provided for in the *Australian Standard* AS/NZS 61000.3.6 (2001).

(c) Planning levels for inter-harmonic *voltage* distortion are specified in clause 17 of the *Network Planning Criteria*.

2.4.2.3 *Voltage* notching

Voltage notching may also arise from large convertors or power electronics equipment with Pulse Width Modulation (PWM) converters interfacing with the *power system*.

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

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

(b) the average of start notch depth and end notch depth shall not exceed 20% of the nominal fundamental peak *voltage*; and

(c) the peak amplitude of oscillations due to commutation at the start and end of the voltage notch shall not exceed 20% of the nominal fundamental peak voltage.

2.4.2.4 Harmonic current distortion

(a) The harmonic *voltage* distortion limits of clause 2.4.2 apply to each phase and are not to be exceeded by a *User* injecting harmonic currents at any of its *connection point*s.

(b) Any induced noise interference to telecommunications lines by a *User's load* due to harmonic currents is not acceptable and the *User* is required to reduce the level of harmonic currents so as to contain such interference to limits considered acceptable by the telecommunication *Network Operator*.

(c) The *User's load* shall not cause any harmonic resonance in other *Users'* systems or the *Network Operator's network*.

2.4.2.5 Direct current

(a) *Users' plant* and equipment shall comply with the requirements on direct current components as stipulated in clause 3.12 of *Australian Standard* AS/NZS 3100:2009. In particular, the direct current in the neutral caused by the *Users' plant* and equipment shall not exceed 120mA.h per *day*.

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

(c) Responsibility of the *Network Operator* for direct current in the neutral outside the limits specified in this clause 2.4.2.5 shall be limited to direct current in the neutral caused by *network* assets.

(d) A *User* whose *plant* is identified by the *Network Operator* as not performing to the standards specified in this clause 2.4.2.5 shall take such measures as may be necessary to meet *Australian Standard* AS/NZS 3100:2009.

2.4.3 *Voltage* Unbalance

(a) For normal system operation and for planned system *outages*, the average *voltage* unbalance measured over a half hour at a *connection point* should not exceed the amount shown in Figure 4~~Table 4~~.

Figure 4 - *Voltage* unbalance limits

Nominal ***supply voltage***	Maximum negative sequence ***voltage*** (% of nominal *voltage*)
132 kV	1.0
11-66 kV	1.5
Low voltage	2.0
An increase in the negative phase sequence *voltage* of up to 50% of the above is permissible for an aggregate of up to 5 minutes in any 30-minute period.	

2.5 Electromagnetic interference

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

2.6 Stability

2.6.1 ~~Transient rotor angle stability~~[Superseded]

~~All *Generation Units connected* to the *transmission* system and *Generation Units* within *power stations* that are *connected* to the *network* and that are classified as *large generators* shall remain in synchronism following a *credible contingency event*.~~

2.6.2 Dynamic stability

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

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

(b) The damping ratio of electromechanical oscillations shall be at least 0.1.

(c) For electromechanical oscillations as a result of a small disturbance, the damping ratio of the oscillation shall be at least 0.5.

(d) In addition to the requirements of clauses 2.6.2(a) and 2.6.2(b), the halving *time* of any electromechanical oscillations shall not exceed 5 seconds.

(e) If oscillations do not comply with clause 2.6.2(d), then appropriate measures shall be taken to *change* the *power system* configuration and/or ~~*Generation*~~ *generation dispatch* so as to eliminate such oscillations. Such measures shall be taken by automatic means.

(f) *Users* who may cause subsynchronous or supersynchronous resonance oscillations shall provide appropriate measures at the planning and design stage to prevent the introduction of this problem to the *Network Operator's power system* or other *Users'* systems.

2.6.3 Short term *voltage* stability

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

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

2.7 *Contingency criteria* for the *network*

To a great extent, the contingency criteria used for the design of the *network* will determine the inherent *reliability* of *customer supply*. These criteria apply to the shared *network*, and not to *customer connection*s.

(a) The contingency levels to which the *network* and sub-clauses of the *network* are designed are set out in clause 14 of the *Network Planning Criteria*.

(b) The contingency criteria in this clause 2.7 apply only to the *electricity network*s and not to *customer connection*s to the *network*.

(c) The contingency criteria for a sub-clause of the *network* may be varied by *Power and Water* following a risk/benefit analysis and other considerations such as capital investment priorities, social needs, the environment and land use.

(d) Connection assets will be designed in accordance with a *User's* requirements and a *Network User* may choose a design configuration having a greater or lesser level of security for its dedicated *connection* to the shared *network*, subject to the approval of *Power and Water*.

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

2.8 Equipment fault level ratings

(a) The *Network Operator* shall specify the minimum fault level ratings of equipment *connect*ed to the *network*.

(b) Unless otherwise agreed by the *Network Operator*, the equipment fault level ratings specified in clause 15.4 of the *Network Planning Criteria* shall apply.

2.9 *Protection* arrangements

2.9.1 *Users'* obligation to provide adequate *protection*

2.9.1.1 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.

2.9.1.2 System *reliability* and integrity

(a) The *Network Operator* and *Users* shall ensure that any new equipment *connect*ed to any part of the system is protected in accordance with the requirements of clause 2.9.

(b) Where the *connection* of new equipment would affect *critical fault clearance times*, the *protection* of both new and existing equipment throughout the *power system* shall meet the new *critical fault clearance times*.

(c) Where existing *protection* would not meet the new *critical fault clearance times*, that *protection* shall be upgraded.

(d) *Fault clearance time* requirements may not be established until all new *plant* data is available and the detailed design of a *User's connection* or *network* reinforcement has commenced.

(e) All faults of any type shall be cleared within the times specified in clause 2.9.5 unless it can be established by the *Network Operator* that a longer clearance *time* would not result in the *network* failing to meet the performance standards set out in clause 2.

2.9.1.3 Minimum standard of *protection* equipment

*Protection system*s shall be designed, installed and maintained in accordance with *good electricity industry practice*. In particular, the *Network Operator* shall ensure that all new *protection apparatus* including that installed on *User's* equipment complies with IEC Standard 60255 and that all new *current transformer*s and *voltage transformer*s comply with *Australian Standard* AS 60044.1 (2007) and *Australian Standard* AS 60044.2 (2007).

2.9.1.4 General requirements

(a) All *primary equipment* on the *network* shall be protected so that if an equipment fault occurs, the faulted equipment item is automatically removed from service by the operation of circuit breakers or fuses.

(b) *Protection system*s shall be designed and their settings coordinated so that, if there is a fault, unnecessary equipment damage is avoided and any reduction in *power transfer capability* or in the level of service provided to *Users* is minimised.

(c) Consistent with the requirement of clause 2.9.1.4(b), *protection system*s shall remove faulted equipment from service in a timely manner and ensure that, where practical, those parts of the *network* not directly affected by a fault remain in service.

2.9.2 Duplication of *protection*

To implement a "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 and intertripping arrangements.

2.9.2.1 Equipment *connect*ed at *voltage*s of 66 kV and above

(a) *Primary equipment* shall be protected by a main *protection system* that shall remove from service only those items of *primary equipment* directly affected by a fault.

(b) The main *protection system* shall comprise *two fully independent protection schemes of differing principle*, *connect*ed to operate in a *"*one out of two*"* arrangement.

(c) One of the independent *protection scheme*s shall include earth fault *protection*.

(d) To maintain the integrity of the two *protection scheme*s, no electrical cross *connection*s shall be made between them.

(e) It shall be possible to test and maintain either *protection scheme* independently without affecting the other.

(f) Where both *protection scheme*s require end-to-end communications, independent *teleprotection signalling* equipment and communication channels shall be provided.

(g) Where failure of the *teleprotection signalling* would result in the failure of both *protection scheme*s to meet the requirements of this clause 2.9.2.1 independent communication bearers shall be provided.

(h) *Primary equipment* shall also be protected by a back-up *protection system* in addition to the main *protection system*. The back-up *protection system* shall isolate the faulted *primary equipment* if a circuit breaker fails to operate.

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

2.9.2.2 Equipment *connect*ed at *voltage*s of less than 66 kV

(a) Each item of *primary equipment* shall be protected by two independent *protection system*s.

(b) One of the independent *protection system*s shall be a main *protection system* that shall remove from service only the faulted item of *primary equipment*.

(c) At least one of the *protection scheme*s shall include earth fault *protection* so as to give additional coverage for low level earth faults and to provide some remote backup.

(d) The other independent *protection system* may be a back-up *protection system*.

(e) Notwithstanding the requirements of clause 2.9.2.2(a), where a part of the *distribution system* may potentially form a separate island the *protection system* that provides *protection* against islanding shall comprise *two fully independent protection schemes of differing principle*.

(f) Where appropriate, and with the approval of the *Network Operator*, a single set of high rupturing capacity (HRC) fuses may be used as a *protection scheme* for *plant* at 33 kV and below, in which case a second *protection scheme* would not be required to satisfy the requirements of this clause 2.9.2.2.

2.9.3 Availability of *protection system*s

All *protection scheme*s on the *network*, including any back-up or *circuit breaker failure protection scheme* and associated intertripping, shall be kept operational at all times except when maintenance is required.

2.9.4 Maximum total fault clearance times

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

(b) For *primary equipment* operating at *transmission system voltages* of 132 kV and 66 kV the maximum total fault clearance times in Figure 5~~Table 5~~ apply to the nominal *voltage* of the circuit breaker that clears a particular fault for both minimum and maximum *system* conditions. For *primary equipment* operating at *distribution system voltages* of 33 kV and below the maximum total fault clearance times specified in Figure 6~~Table 6~~ may be applied to all circuit breakers required to clear a fault for maximum system conditions, irrespective of the nominal *voltage* of the circuit breaker.

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

(1) Both of the *protection schemes* of the main protection system must operate to achieve a total fault clearance time no greater than the "No CB Fail" time given in Figure 5~~Table 5~~. The backup protection system must achieve a total fault clearance time no greater than the "CB Fail" time in Figure 5~~Table 5~~, except that the second protection scheme that protects against small zone faults must achieve a total fault clearance time no greater than 400 msec;

(2) For a small zone fault coupled with a circuit breaker failure, maximum total fault clearance times are not defined.

(3) In Figure 5~~Table 5~~, for voltages of 66 kV and above, the term "local" refers to the circuit breaker(s) of a protection system where the fault is located:

(i) within the same *substation* as the circuit breaker;

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

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

(4) In Table 5, for voltages of 66 kV and above, the term "remote" refers to all circuit breakers required to clear a fault, apart from those specified in clause 2.9.4(c)(3).

(d) In Figure 6~~Table 6~~, for *primary equipment* operating at nominal voltage of 33 kV and below, the term "local" refers only to faults located within the *substation* in which a circuit breaker is located.

Figure 5 – 132 kV and 66 kV *maximum total fault clearance times* (msec)

		No CB Fail	CB Fail
132 kV and 66 kV	Local	150	400
	Remote	200	450

Figure 6 – 33 kV and below *maximum total fault clearance times* (msec)

		No CB Fail	CB Fail
33 kV and below	Local	1160	1500
	Remote	Not defined	Not defined

2.9.5 *Critical fault clearance times*

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

2.9.5.1 *Critical fault clearance times*

Where a *critical fault clearance time* to p*reserve* system stability has been established by the *Network Operator* in a portion of the *network*:

(a) For *plant* operating at *voltage*s of 66 kV or higher, each of the two independent *protection schemes* shall be capable of detecting and clearing *plant* faults within the *critical fault clearance time*.

(b) Where a *critical fault clearance time* exists for *plant* operating at 33 kV and below:

(1) one *protection scheme* shall be capable of detecting and clearing *plant* faults within the *critical fault clearance time*; and

(2) the second *protection scheme* is required to meet the maximum acceptable *fault clearance times* set out in clause (c).

(c) Other *critical fault clearance time* requirements may be imposed by the *Network Operator* to limit system *voltage* and/or *frequency* disturbances resulting from faults.

2.9.6 Protection sensitivity

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

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

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

2.9.7 Trip supply supervision

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

2.9.8 *Trip circuit supervision*

All protection scheme secondary circuits that include a circuit breaker trip coil must have trip circuit supervision, which monitor the health of the trip coil under both circuit breaker opened and closed positions.

2.9.9 *Protection flagging, indication, fault and event records*

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

Any failure of the tripping supplies, protection apparatus and circuit breaker trip oils must be alarmed and operating procedures must be put in place to ensure that prompt action is taken to remedy such failures.

2.10 Variation of service quality parameters

(a) In particular circumstances, the requirements in clause 2 of this *Code* may be varied.

(b) The *Network Operator* may vary the *Code* in accordance with the *derogation* provisions of clause 12~~12~~.

(c) Where it is intended to vary the requirements set out in this *Code*, it shall be demonstrated that the variation will not adversely affect *Users* or *power system security*.

3 Technical requirements for equipment *connect*ed to the *network*

3.1 Introduction

(a) The objective of this clause 3 is to facilitate maintenance of the *power system* service quality parameters specified in clause 2, so that other *Users* are not adversely affected and that personnel and equipment safety are not put at risk.

(b) This clause sets out details of the technical requirements which *Users* shall satisfy as a condition of *connection* of any equipment to the *network* including, but not limited, to the following types of equipment:

(1) *Generating units*~~*Generation Units*~~ *connect*ed at all *voltage* levels of the *network*;

(2) Small ~~*Generation Units*~~ *generating systems* *connect*ed at *voltage*s of 22 kV and below;

(3) *Small Inverter Energy System*s *connect*ed to the *low voltage network*; and

(4) *Load*s, including those with electronic switching systems, *connect*ed at all *voltage* levels of the *network*.

(c) The *Network Operator* shall determine the classification of equipment to be connected to the *network* and may alter the technical requirements of connection in this clause 3 in respect of a particular *connection* only as much as is necessary to ensure the *power system* service quality parameters specified in clause 2 are maintained.

(d) An exemption may be granted by the *Network Operator* to certain provisions in clause 3~~3~~ in accordance with the *derogation*s in clause 12~~12~~ of the *Code*.

3.2 Requirements for ~~all~~ *Network Users* *excluding Generator Users under clause 3.3*

The requirements under this clause apply to all ~~n~~*Network* ~~u~~*Users* except ~~g~~*Generator* ~~u~~*Users* captured under clause 3.3, unless expressly referred ~~enced to by~~ to in a subclause within clause 3.3.

~~3.1.1~~3.2.1 *Network* performance standards

A *User* shall ensure that each of its facilities *connect*ed to the *network* is capable of operation while the *power system* is operating within the parameters of the performance standards set out in clause 1.7.2.

~~3.1.1.1~~3.2.1.1 *Voltage* fluctuations

A *User* shall maintain its contributions to flicker at the *connection point* to below the limits allocated by the *Network Operator* under clause 2.4.1.

~~3.1.1.2~~3.2.1.2 Harmonic *voltage* distortion

(a) A *User* shall comply with any harmonic emission limits allocated by the *Network Operator* in accordance with clause 2.4.2 of the *Code*.

(b) A *User* shall ensure that the injection of harmonics or interharmonics from its equipment or facilities into the *network* does not cause the maximum system harmonic *voltage* levels at the point of *connection* to exceed the levels set out in clause 17.2 of the *Network Planning Criteria*.

~~3.1.1.3~~3.2.1.3 Direct current injection

A *User* shall ensure that any DC component of current produced by its own equipment complies with the requirements of clause 17.2.2 of the *Network Planning Criteria*.

~~3.1.1.4~~3.2.1.4 *Voltage* unbalance

A *User connect*ed to all three phases shall balance the current drawn in each phase at its *connection point* so as to achieve levels of negative sequence *voltage* at all *connection point*s that are equal to or less than the values specified in clause 2.4.3.

~~3.1.1.5~~3.2.1.5 Stability

(a) *Users* shall cooperate with the *Network Operator* to achieve stable operation of the *network*s and shall install emergency controls as reasonably required by the *Network Operator*.

(b) The cost of installation, maintenance and operation of the emergency controls shall be borne by the *User*.

(c) The stability criteria stated in clause 2.6 shall be satisfied under the worst credible system *load* and *generation* pattern, and the most severe *credible contingency event* arising from either a single *credible contingency event* at up to 100% *peak load* or a double *credible contingency event* at up to 80% *peak load*.

(d) *Credible contingency event*s shall be considered in accordance with clause 2.7.

~~3.1.1.6~~3.2.1.6 Electromagnetic interference

A *User* shall ensure that the electromagnetic interference caused by its equipment does not exceed the limits set out in clause 2.5.

~~3.1.1.7~~3.2.1.7 Fault levels

(a) A *User connect*ed to the *network* may not install or *connect* equipment at the *connection point* that is rated for a *maximum fault current* lower than that specified in the ~~*Access Agreement*~~*connection agreement* in accordance with clause 3.6.6.

(b) A *User connect*ed to the *network* shall not install equipment at the *connection point* that is rated for a *maximum fault current* lower than that specified in clause 15.4 of the *Network Planning Criteria* unless a lower *maximum fault current* is agreed with the *Network Operator* and specified in the ~~*Access Agreement*~~*connection agreement*.

(c) Where a *User's* equipment increases the fault levels in the *transmission* system, responsibility for the cost of any upgrades to the equipment required as a result of the *change*d *power system* conditions will be dealt with by commercial arrangements between the *Network Operator* and the *Users*.

~~3.1.1.8~~3.2.1.8 Main switch

Except as provided in clause 1.1.1.1~~3.3.2.11~~, a *User* shall be able to de-*energise* its own equipment without reliance on the *Network Operator*.

~~3.1.1.9~~3.2.1.9 *Users'* power quality *monitoring equipment*

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

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

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

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

~~3.1.1.10~~3.2.1.10 *Power system* simulation studies

(a) A *User* shall provide to the *Network Operator* such of the following information relating to any of the *User's* facilities *connect*ed or intended to be *connect*ed to the *transmission* system as is required to enable the undertaking of *power system* simulation studies:

(1) a set of functional block diagrams, including all transfer functions between feedback signals and *generating unit* ~~*Generation Unit*~~ output;

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

(3) the characteristics of non-linear elements.

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

~~3.1.1.11~~3.2.1.11 Technical matters to be coordinated

(a) The *User* and the *Network Operator* shall use all reasonable endeavours to agree upon the following matters in respect of each new or altered *connection*:

(1) design at *connection point*;

(2) physical layout adjacent to *connection point*;

(3) *protection* and backup;

(4) control characteristics;

(5) communications, metered quantities and alarms;

(6) insulation co-ordination and lightning *protection*;

(7) fault levels and fault clearing times;

(8) switching and isolation facilities;

(9) interlocking arrangements;

(10) *metering* installations as described in clause 10;

(11) *synchronising* facilities;

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

(13) out of step/pole slip *facility*; and

(14) any special test requirements.

(b) Prior to *connection* to the *Network Operator's power system*, the *Users* shall have provided to the *Network Operator* a signed statement to certify that the equipment to be *connect*ed has been designed and installed in accordance with this *Code*, all relevant standards, all statutory requirements and *good electricity industry practice*.

~~3.1.2~~3.2.2 Provision of information

(a) A *User* shall provide all data reasonably required by the *Network Operator*.

(b) Details of the kinds of data that may be required are included in clause 11 and Attachment 3 of this *Code*.

~~3.1.3~~3.2.3 *Protection* requirements

Protection shall be provided to detect and clear faults, without system instability and without causing equipment damage, in accordance with clauses 2.6 and 2.9.

~~3.1.3.1~~3.2.3.1 *Transmission lines* and other *Plant* operated at 66 kV and above

(a) *Protection* shall be by two fully independent *protection schemes* as set out in clause 2.9.2.1.

(b) The *protection* arrangements shall be capable of clearing a fault within the clearance times set out in clause 2.9.5.

~~3.1.3.2~~3.2.3.2 *Interconnectors* and ties operated at 33 kV and below

(a) *Protection* shall be by two fully independent *protection schemes* as set out in clause 2.9.2.2.

(b) The *protection* arrangements shall be capable of clearing a fault within the clearance times set out in clause 2.9.5.

~~3.1.3.3~~3.2.3.3 Feeders, *reactors*, *capacitors* and other *plant* operated at 33 kV and below

(a) The *protection* arrangements shall be capable of clearing a fault within the clearance times set out in clause 2.9.5.

(b) Where a *critical fault clearance time* exists, *protection* of these items will be by two independent *protection schemes* of *differing principle*, each one discriminating with the *Network Operator power system* and capable of meeting the *critical fault clearance time*.

(c) At least one of these *protection schemes* shall also include earth fault *protection* so as to give additional coverage for low level earth faults and to provide some remote backup.

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

  (1) three Phase Inverse Definite Minimum *Time* Overcurrent; and

  (2) three Phase Instantaneous Overcurrent; and

  (3) inverse Definite Minimum Time Earth Fault; and

  (4) instantaneous Earth Fault.

(e) With the approval of the *Network Operator,* a single set of HRC fuses may be deemed to provide equivalent *protection* to subclause (c) of this clause 3.2.3.3.

~~3.1.3.4~~3.2.3.4 *Transformers*

The composition of each of the two *protection schemes* should be *complementary* such that, in combination, they provide dependable clearance of *transformer* faults within a specified *time*. With any single failure to operate of the *secondary plant*, fault clearance shall still be achieved by *transformer protection*, but may be delayed until the nature of the fault *changes* or evolves. *Protection* of *transformers* larger than 3 MVA will require at least one of the *protection schemes* to be a unit *protection* and provide high-speed fault clearance of *transformer* faults.

(a) For *transformers* with a primary *voltage* of 66 kV and above, *protection* shall be by two fully independent *protection schemes* as set out in clause 2.9.2.1.

(b) For *transformers* with a primary *voltage* of 33 kV and below, *protection* shall be by two *protection schemes* which are *complementary*, as set out in clause 2.9.2.2.

(c) The *protection* arrangements shall be capable of clearing a fault within the clearance times set out in clause 2.9.5.

~~3.1.3.5~~3.2.3.5 *Protection* discrimination

Where the *Network Operator protection* is overcurrent, the maximum operate *time* will be 1 second at maximum fault level. Generally, *Network Operator* overcurrent and earth fault *protection* employs devices with standard inverse characteristics to BS142 with a 3 second curve at 10 times current and *time* multiplier of 1.0. Note that this is the specification of the characteristic rather than the device setting. Operating times for other types of *protection* will generally be lower and will be dependent upon location.

The *protection* in clauses 3.2.3.1, 3.2.3.2, 3.2.3.3 and 3.2.3.4 is required to discriminate with the *Network Operator's protection* on the *power system*.

~~3.1.3.6~~3.2.3.6 *Backup protection*

(a) The *protection* in clauses 3.2.3.1, 3.2.3.2, 3.2.3.3 and 3.2.3.4 is required to be backed up by an independent *protection* to ensure clearance of faults with a *protection* failure.

(b) *Backup protection* shall be provided to detect and clear faults involving small zones.

(c) *Protection* shall be provided to detect and clear faults involving *circuit breaker failure*.

(d) Where *critical fault clearance times* do not exist, or are greater than the times given in clause 2.9.5, the clearance times are to be as specified by the *Network Operator* in a~~n~~ ~~*Access Agreement*~~*connection agreement*.

(e) Such *protection schemes* shall be capable of detecting and initiating clearance of uncleared or *small zone faults* under both normal and *minimum system conditions*.

(f) Under abnormal *plant* conditions, all primary system faults shall be detected and cleared by at least one *protection scheme* on the *User's* equipment. *Remote backup protection* or standby *protection* may be used for this purpose.

~~3.1.3.7~~3.2.3.7 *Protection* alarm requirements

(a) Specific requirements and the interface point to which alarms shall be provided will be mutually decided during the detailed design phase. These alarms will be brought back to the *Network Operator's control centre* via the installed *SCADA system* supplied by the *User* in accordance with clause 3.2.5 or clause 1.1.1~~3.3.3~~, as applicable.

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

~~3.1.3.8~~3.2.3.8 Islanding of a *User's* facilities from the *power system*

(a) Unless otherwise agreed by the *Network Operator,* a *User* shall ensure that islanding of its ~~*Generation*~~ *generation* *plant* together with part of the *Network Operator power system*, cannot occur upon loss of *supply* from the *Network Operator's power system*.

(b) Clause 3.2.3.8(a) should not preclude a design that allows a *User* to island its own ~~*Generation*~~ *generation* and *plant load*, thereby maintaining *supply* to that *plant*, upon loss of *supply* from the *Network Operator's power system*.

(c) Islanding shall only occur in situations where *Power and Water*'s *power system* is unlikely to recover from a major disturbance.

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

(e) *Users* shall co-operate to agree with the *Network Operator* the type of initiating signal and settings to ensure compatibility with other *protection* settings on the *network* and to ensure compliance with the requirements of clause 2.2.

(f) Where a *User* does not wish to meet the requirements of clause 2.2, appropriate commercial arrangements will be required between the *User*, the *Network Operator* and/or another *User*(s) to account for the higher level of access service.

~~3.1.3.9~~3.2.3.9 *Automatic reclose equipment*

The installation and use of *automatic reclose equipment* in a *User's facility* and in the *power system* shall only be permitted with the prior written agreement of *Network Operator*.

~~3.1.3.10~~3.2.3.10 Maintenance of *protection*

(a) *Users* shall regularly maintain their *protection systems* at intervals of not more than 3 years. Records shall be kept of such maintenance and the *Network Operator* may review these. Refer also to clause 5.2.

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

(c) 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.

~~3.1.4~~3.2.4 Design requirements for *Users' substations*

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

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

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

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

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

(e) *Synchronisation* facilities or reclose blocking shall be provided if ~~*Generating*~~ *generating units* ~~*Units*~~ are *connect*ed through the *substation*.

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

(g) *Plant* shall be tested to ensure that the *substation* complies with the design and specifications required by clause 3.2.3.10. Where appropriate, type test certificates provided by the manufacturer satisfy this clause.

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

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

(j) Prior to *connection* to the *Network Operator's power system*, the *User* shall have provided to the *Network Operator* a signed written statement to certify that the equipment to be *connect*ed has been designed and installed in accordance with:

   (1) this *Code;*

   (2) all relevant standards;

   (3) all statutory requirements; and

   (4) *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.

~~3.1.5~~3.2.5 Remote monitoring and control requirements

(a) The *Network Operator* may require the *User* to:

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

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

(b) The *RME* provided, upgraded, modified or replaced (as applicable) under subclause (a) shall conform to an acceptable standard as agreed by the *Network Operator* and shall be compatible with the *Network Operator's SCADA system*, including the requirements of clause 4.9 of this *Code*.

(c) Input information to *RME* may include, but not be limited to, the following:

(1) Status Indications

(i) relevant circuit breakers open/closed (double pole) within the *plant*

(ii) relevant isolators within the *plant*

(iii) *connection* to the *network*

(2) Alarms

(i) *protection* fail

(ii) battery fail - AC and DC

(iii) *Trip circuit supervision*

(iv) *Trip supply supervision*

(3) Measured Values

(i) *active power load*

(ii) *reactive power load*

(iii) *load* current

(iv) relevant *voltages* throughout the *plant*

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

(i) *protection* operation

(ii) circuit breaker status

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

~~3.1.6~~3.2.6 Communications equipment

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

(b) A *User* shall provide communications paths (with appropriate redundancy) between any *RME* installed at its *plant* to a communications interface at the relevant *plant* and in a location reasonably acceptable to the *Network Operator*.

(c) Communications systems between this communications interface and the relevant *control centre* shall be the responsibility of the *Network Operator* unless otherwise agreed.

(d) The cost of the communications systems shall be met by the *User*, unless otherwise determined by the *Network Operator*.

~~3.1.7~~3.2.7 Secure electricity supplies

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

~~3.1.8~~3.2.8 *Load shedding* facilities

If reasonably required by the *Network Operator*, *Users* are to provide automatic *interruptible load* to the *Network Operator* in accordance with clause 2.2.2.

~~3.1.8.1~~3.2.8.1 *Load* to be available for *disconnection*

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

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

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

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

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

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

(d) Subject to clauses 4.3.4(c) and 4.3.4(d), arrangements for *load shedding* shall be agreed between the *Network Operator* and *User* and can include the opening of circuits in a *network*.

(e) The *Network Operator* shall specify, in the ~~*Access Agreement*~~*connection agreement*, control and monitoring requirements to be provided by a *User* for *load shedding* facilities.

~~3.1.8.2~~3.2.8.2 Installation and testing of *load shedding* facilities

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

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

(b) Co-operate with the *Network Operator* in conducting periodic functional testing of the facilities, which shall not require *load* to be *disconnect*ed, provided facilities are available to test the scheme without shedding *load*.

(c) Apply *under frequency* settings to relays as determined by the *Power System Controller*.

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

~~3.1.9~~3.2.9 Impact on *power system* performance

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

(b) These studies may be performed by the *User* or a third party, in which case, the *Network Operator* will require full details of the studies performed including, without limitation:

(1) assumptions made;

(2) results;

(3) conclusions; and

(4) recommendations.

(c) The acceptance of studies performed by a *User* or a third party will be entirely at the *Network Operator's* discretion.

(d) Acceptance of *power system* studies by the *Network Operator* does not absolve *Users* of responsibility/liability for damages or losses incurred by others.

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

(f) The *Network Operator* will make the final determination on the suitability of a *User's* facilities and the requirements to be fulfilled prior to and after the facilities are *connect*ed, in accordance with this *Code*.

~~3.1.10~~3.2.10 Safety criteria

(a) 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.

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

~~3.1.11~~3.2.11 Environmental criteria

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

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

~~3.1.12~~3.2.12 Construction criteria

~~3.1.12.1~~3.2.12.1 Overhead lines

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

~~3.1.12.2~~3.2.12.2 Underground cables

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

3.3 Requirements for *connection* of *Generators*

This clause 3.3 ~~The following collective clauses are directly mappable and have~~ has been adapted from the National Electricity Rules v114 Schedule 5.2 for use in the Northern Territory ~~and are collectively referred to in this clause as clause3.3~~.

3.3.1 Outline of Requirements

(a) This clause 3.3 sets out details of additional requirements and conditions that *Generators* must satisfy as a condition of connection of a *generating system* to the *power system*.

(b) This clause 3.3 applies to *Generators* with a *generating system* that:

i. meets any materiality threshold established in a Northern Territory regulatory instrument for this purpose; or

ii. is connected or intended for use in a manner the *Network Operator* considers is likely to cause a material degradation in the quality of supply to other *Network Users*; or

~~i.~~iii. in the absence a materiality threshold referred to in subparagraph (i) above, has a rating of 2 MW or more.

Note: Generators that undertake the process under Chapter 5A or clause 5.3A of the NT NER may be assessed by the Network Operator in full or in part against the criteria under clause 3.3.5 of this Code.

~~This clause 3.3 applies to :~~

~~Prior to 1 July 2019, a *Generator* that is required to be licensed by the Utilities Commission and / or meets the registration thresholds outlined in clause 19 of the System Secure Guidelines.~~

~~After 1 July 2019, a *generator* that connects under the NT NER Chapter 5.~~

~~This clause 3.3 does not apply to any generating system that is:~~

~~subject to an exemption from registration; or~~

~~eligible for exemption under any guidelines issued,~~

~~and which is connected or intended for use in a manner the *Network Operator* considers is unlikely to cause a material degradation in the quality of supply to other *Network Users*.~~

(c) This clause 3.3 also sets out the requirements and conditions which subject to clause 3.3.5, are obligations on *Generators*:

(1) to co-operate with the relevant *Network Operator* on technical matters when making a new connection; and

(2) to provide information to the *Network Operator* or *Power System Controller*.

(d) The equipment associated with each *generating system* must be designed to withstand without damage the range of operating conditions which may arise consistent with the system standards.

(e) *Generators* must comply with the performance standards and any attached terms or conditions of agreement agreed with the *Network Operator* or *Power System Controller* in accordance with a relevant provision of clauses 2.2 to 2.6 inclusive.

(f) This clause 3.3 does not set out arrangements by which a *Generator* may enter into an agreement or contract with the *Power System Controller* to:

(1) provide additional services that are necessary to maintain power system security; or

(2) provide additional services to facilitate management of the market.

(g) This clause 3.3 provides for ~~automatic access standards~~*automatic access standards* and the determination of *negotiated access standards* which once determined, must be recorded together with the ~~automatic access standards~~*automatic access standards* in a *connection agreement* and registered with the *Power System Controller* as performance standards.

3.3.2 Application of Settings

A *Generator* must only apply settings to a control system or a protection system that are necessary to comply with performance requirements of this clause 3.3 if the settings have been approved in writing by the relevant *Network Operator* and, if the requirement is one that would involve the *Power System Controller* (being a *negotiated access standard*), also by the *Power System Controller*. A ~~Generator~~*Generator* must not allow its generating unit to supply electricity to the power system without such prior approval.

If a ~~Generator~~*Generator* seeks approval from the *Network Operator* to apply or change a setting, then (except in the case of settings to be applied or changed by the ~~Generator~~*Generator* in connection with an emergency frequency control scheme) approval must not be withheld unless the *Network Operator* or, if the requirement is one that would involve the *Power System Controller* (being a *negotiated access standard*), the *Power System Controller*, reasonably determines that the changed setting would cause the generating unit to not comply with the relevant performance standard or cause an intra-regional power transfer capability to be reduced.

If the *Network Operator* or, if the requirement is one that would involve the *Power System Controller* (being a *negotiated access standard*), the *Power System Controller*, reasonably determines that a setting of a generating unit's control system or protection system needs to change to comply with the relevant performance standard or to maintain or restore an intra-regional power transfer capability, the *Network Operator* or involve the *Power System Controller* (as applicable) must consult with the relevant ~~Generator~~*Generator*, and the *Network Operator* may request in writing that a setting be applied in accordance with the determination.

The *Network Operator* may also request a test to verify the performance of the relevant plant with the new setting. The *Network Operator* must provide the *Power System Controller* with a copy of its request to a ~~Generator~~*Generator* to apply a setting or to conduct a test.

A ~~Generator~~*Generator* who receives such a request must arrange for the notified setting to be applied as requested and for a test to be conducted as requested. After the test, the ~~Generator~~*Generator* must, on request, provide both the *Power System Controller* and the *Network Operator* with a report of a requested test, including evidence of its success or failure. Such a report of a test is confidential information.

A ~~Generator~~*Generator* must not change a setting requested by the *Network Operator* without its prior written agreement. If the *Network Operator* requires a ~~Generator~~*Generator* to change a setting within 18 months of a previous request, the *Network Operator* must pay the ~~Generator~~*Generator* its reasonable costs of changing the setting and conducting the tests as requested.

3.3.3 Technical Matters to be Co-ordinated

(a) A ~~Generator~~*Generator* and the relevant *Network Operator* must use all reasonable endeavours to agree upon relevant technical matters in respect of each new or altered connection of a *generating system* to a *network* including:

(1) design at the *connection point;*

(2) physical layout adjacent to the *connection point*;

(3) primary protection and backup protection;

(4) control characteristics;

(5) communications facilities;

(6) insulation co-ordination and lightning protection (paragraph (b));

(7) fault levels and fault clearance;

(8) switching and isolation facilities;

(9) interlocking and synchronising arrangements; and

(10) metering installations as described in Chapter 7A of ~~clause~~ .the *NT NER*.

(b) A ~~Generator~~*Generator* must ensure that in designing a generating system's electrical plant, including any substation for the connection of the generating system to the network, to operate at the same nominal voltage as at the connection point:

(1) the plant complies with the relevant Australian Standards unless a provision of this Code allows or requires otherwise;

(2) the earthing of the plant complies with the ENA EG1-2006: Substation Earthing Guide to reduce step and touch potentials to safe levels;

(3) the plant is capable of withstanding, without damage the voltage impulse levels specified in the *connection agreement*;

(4) the insulation levels of the plant are co-ordinated with the insulation levels of the network to which the generating system is connected as specified in the *connection agreement*; and

(5) safety provisions in respect of the plant comply with requirements applicable to the participating jurisdiction in which the generating system is located, as notified by the *Network Operator*.

(c) If no relevant Australian Standard exists for the purposes of paragraph (b)(1), the ~~Generator~~*Generator* must agree with the *Network Operator* for the ~~Generator~~*Generator* to comply with another relevant standard.

(d) Prior to connection to the *Network Operator*'s power system, the Users shall have provided to the *Network Operator* a signed statement to certify that the equipment to be connected has been designed and installed in accordance with this Code, all relevant standards, all statutory requirements and good electricity industry practice.

3.3.4 Provision of Information

(a) A ~~Generator~~*Generator* shall provide the data specified in clause 11.2.

(b) The ~~Generator~~*Generator* shall provide all other data reasonably required by the *Network Operator*. This data shall include, without limitation, full models (and all model parameters) of:

(1) the ~~Generation Units~~*generating units*;

(2) the excitation control systems;

(3) turbine / engine governor systems; and

(4) power system stabilisers;

(5) to enable the *Network Operator* to conduct dynamic simulations.

(c) These models shall be in a form which is compatible with the power system analysis software used by the *Network Operator* (currently PSS/E from Siemens PTI and PowerFactory) and shall be inherently stable.

(d) Details of the kinds of data that may be required are included in Attachment 3 of this Code, specifically:

(1) Schedule S3.1 - Generating~~on~~ u~~U~~nit design data;

(2) Schedule S3.2 - Generati~~o~~ng ~~U~~unit setting data;

(3) Schedule S3.5 - Network and plant technical data; and

(4) Schedule S3.6 - Network plant and apparatus setting data.

3.3.5 Technical Requirements

The following technical requirements describe the ~~automatic access standards~~*automatic access standards* for new or modification of existing, *generating units* or *generating systems* seeking connection to the network. A connection applicant may propose an alternative *negotiated access standard* by applying the following:

(a) A *negotiated access standard* must:

(1) be set at a level that will not adversely affect power system security;

(2) be set at a level that will not adversely affect the quality of supply for other ~~N~~*Network Users*.

(b) When submitting a proposal for a *negotiated access standard*, a ~~C~~connection ~~A~~applicant must propose a standard that is as close as practicable to the corresponding automatic access standard, having regard to:

(1) the need to protect the plant from damage;

(2) power system conditions at the location of the proposed connection; and

(3) the commercial and technical feasibility of complying with the automatic access standard with respect to the relevant technical requirement.

(c) When proposing a *negotiated access standard* under paragraph (b), the connection applicant must provide reasons and evidence to the *Network*

Operator and *Power System Controller* as to why, in the reasonable opinion of the connection applicant, the proposed *negotiated access standard* is appropriate, including:

(1) how the connection applicant has taken into account the matters outlined in subparagraphs (b)(1) to (3); and

(2) how the proposed *negotiated access standard* meets the requirements of paragraph (a).

3.3.5.1 Reactive Power Capability

(a) The automatic access standard is a *generating system* operating at:

(1) any level of active power output; and

(2) any voltage at the connection point within the limits established under clause 15.2 (a) without a contingency event,

must be capable of supplying and absorbing continuously at its *connection point* an amount of reactive power of at least the amount equal to the product of the rated active power of the ~~*Generating System*~~*generating system* and 0.~~55~~395.

(b) A performance standard must record the agreed value for rated active power and where relevant the method of determining the value.

(c) A performance standard for consumption of energy by a *generating system* when not supplying or absorbing reactive power under an ancillary services agreement is to be established under clause 3.6 as if the *Generator* were a load.

3.3.5.2 Quality of Electricity Generated

(a) For the purpose of this clause 3.3.5.2 in respect of a synchronous generating unit, AS 1359.101 and IEC 60034-1 are plant standards for harmonic voltage distortion.

(b) The automatic access standard is a ~~*Generating System*~~*generating system* when generating and when not generating must not produce at any of its connection points for generation:

(1) voltage fluctuation greater than the limits allocated by the *Network Operator* under clause 2.4.1;

(2) harmonic voltage distortion greater than the emission limits specified by a plant standard under paragraph (a) or allocated by the *Network Operator* under clause 2.4.2; and

(3) voltage unbalance greater than the limits allocated by the *Network Operator* in accordance with clause 2.4.3.

3.3.5.3 Generating Unit Response to Frequency Disturbance

(a) For the purposes of this clause 3.3.5.3:

normal operating frequency band and abnormal frequency band are references to the widest range specified for those terms for any condition (including an "island" condition) in the *frequency operating standards* that apply to the *region* in which the *generating unit* is located.

stabilisation time means the longest times allowable for the *frequency* of the *power system* to remain outside the normal operating frequency band, for any condition (including an "island" condition) in the *frequency operating standards* that apply to the *region* in which the *generating unit* is located.

transient frequency limit and transient frequency time mean the values of 45 Hz and 2 seconds respectively, or such other values determined by the *Power System Controller*.

(b) The automatic access standard is a generating system and each of its generating units must be capable of continuous uninterrupted operation for frequencies in the following ranges:

(1) the lower bound of the transient frequency limit for at least 2 seconds;

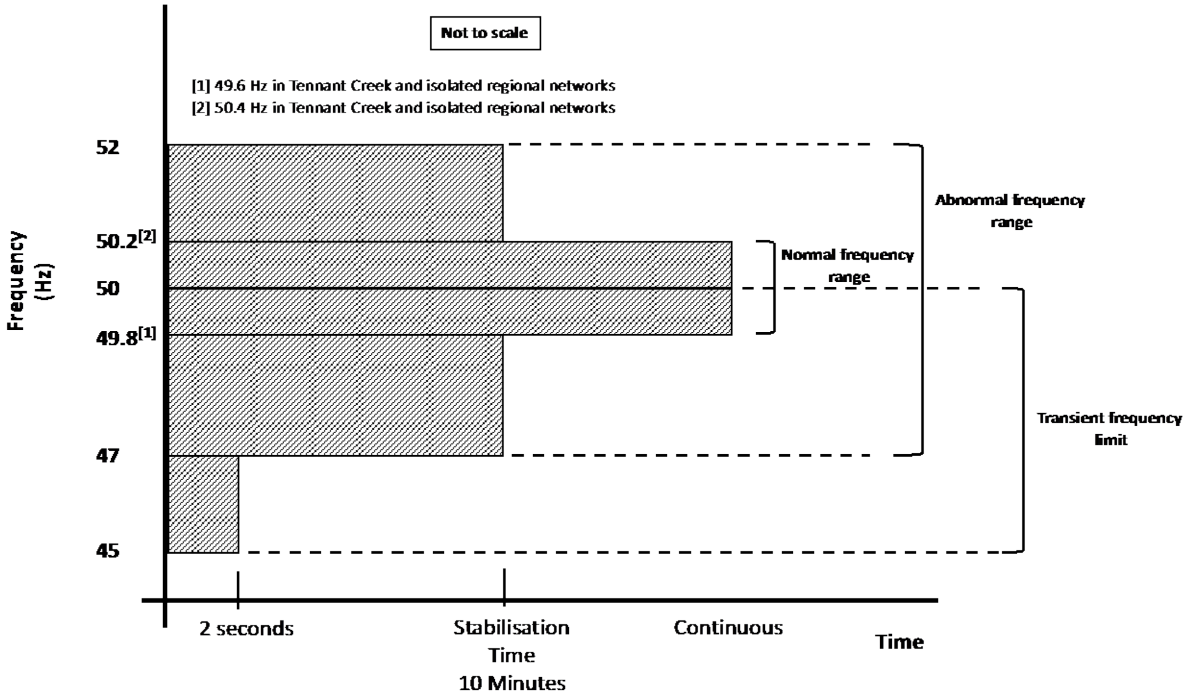
(2) the lower bound of the abnormal frequency excursion tolerance limits to the lower bound of the operational frequency tolerance band for at least the stabilisation time;

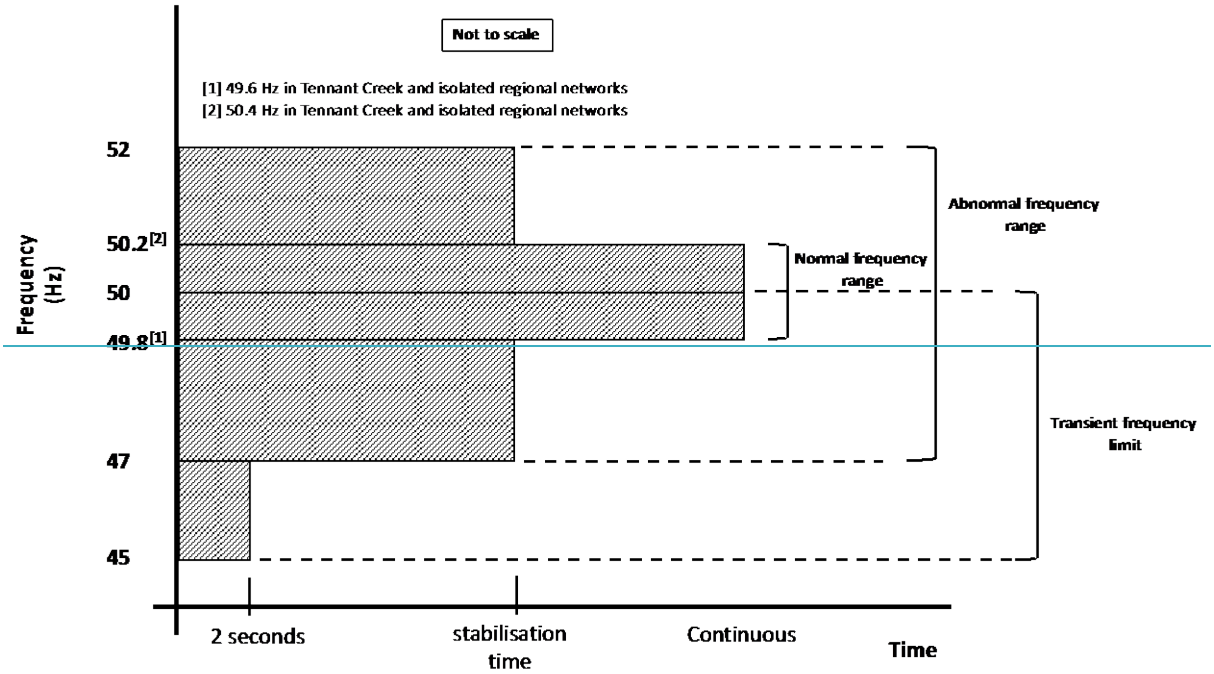
(3) the normal operating frequency band for an indefinite period;

(4) the upper bound of the operational frequency tolerance band to the upper bound of the abnormal frequency excursion tolerance limits for at least the stabilisation time,

unless the *rate of change of frequency* is outside the range of –4 Hz to 4 Hz per second.

The automatic access standard is illustrated in the following diagram reflecting the frequency standards outlined in clauses 2.2.1 and 2.2.2.





3.3.5.4 Generating System Response to Voltage Disturbances

(a) The automatic access standard is a *generating system* and each of its *generating units* must be capable of continuous uninterrupted operation where a power system disturbance causes the voltage at the connection point to vary within the following ranges:

(1) over 130% of normal voltage for a period of at least 0.02 seconds after T(ov);

(2) 125% to 130% of normal voltage for a period of at least 0.2 seconds after T(ov);

(3) 120% to 125% of normal voltage for a period of at least 2.0 seconds after T(ov);

(4) 115% to 120% of normal voltage for a period of at least 20.0 seconds after T(ov);

(5) 110% to 115% of normal voltage for a period of at least 20 minutes after T(ov);

(6) 90% to 110% of normal voltage continuously;

(7) 80% to 90% of normal voltage for a period of at least 10 seconds after T(uv); and

(8) 70% to 80% of normal voltage for a period of at least 2 seconds after T(uv),

~~0% of normal voltage for a period of at least 500 milli- seconds after T(uv)~~

where T(ov) means a point in time when the voltage at the connection point first varied above 110% of normal voltage before returning to between 90% and 110% of normal voltage, and T(uv) means a point in time when the voltage at the connection point first varied below 90% of normal voltage before returning to between 90% and 110% of normal voltage.

(b) The access standard must include any operational arrangements necessary to ensure the *generating system* and each of its *generating units* will meet its agreed performance levels under abnormal *network* or *generating system* conditions.

3.3.5.5 Generating System Response to Disturbances Following Contingency Events

(a) In this clause 3.3.5.5 a fault includes a fault of the relevant type having a metallic conducting path.

(b) The automatic access standard is:

(1) for a *generating system* and each of its *generating units*, the requirements of paragraphs (c) and (d);

(2) for a generating system comprised solely of synchronous generating units, the requirements of paragraph (e);

(3) for a *generating system* comprised solely of asynchronous generating units, the requirements of paragraphs (f) to (i); and

(4) for a *generating system* comprised of synchronous *generating units* and asynchronous *generating units*:

(i) for that part of the *generating system* comprised of *synchronous generating units*, the requirements of paragraph (e); and

(ii) for that part of the *generating system* comprised of asynchronous *generating units*, the requirements of paragraphs (f) to (i).

All generating systems

(c) A *generating system* and each of its *generating units* must remain in continuous uninterrupted operation for any disturbance caused by:

(1) a credible contingency event;

(2) a three phase fault in a transmission system cleared by all relevant primary protection systems;

(3) a two phase to ground, phase to phase or phase to ground fault in a transmission system cleared in:

(i) the longest time expected to be taken for a relevant breaker fail protection system to clear the fault; or

(ii) if a protection system referred to in subparagraph (i) is not installed, the greater of the time specified in clause 2.9.4 Table 5 (or if none is specified, 450 milliseconds) and the longest time expected to be taken for all relevant primary protection systems to clear the fault; or

(4) a three phase, two phase to ground, phase to phase or phase to ground fault in a distribution network cleared in:

(i) the longest time expected to be taken for the breaker fail protection system to clear the fault; or

(ii) if a protection system referred to in subparagraph (i) is not installed, the greater of 1500 milliseconds and the longest time expected to be taken for all relevant primary protection systems to clear the fault,

provided that the event is not one that would disconnect the generating unit from the power system by removing network elements from service.

(d) A *generating system* and each of its *generating units* must remain in continuous uninterrupted operation for a series of up to 15 disturbances within any five minute period caused by any combination of the events described in paragraph (c) where:

(1) up to six of the disturbances cause the *voltage* at the *connection point* to drop below 50% of *normal voltage*;

(2) in parts of the *network* where three-phase automatic reclosure is permitted, up to two of the disturbances are three phase faults, and otherwise, up to one three phase fault where *voltage* at the *connection point* drops below 50% of *normal voltage*;

(3) up to one disturbance is cleared by a *breaker fail protection system* or similar back-up *protection system*;

(4) up to one disturbance causes the *voltage* at the *connection point* to vary within the ranges under clause 3.3.5.4(a)(7) and (a)(8);

(5) the minimum clearance from the end of one disturbance and commencement of the next disturbance may be zero milliseconds; and

(6) all remaining disturbances are caused by faults other than three phase faults,

provided that none of the events would result in:

(7) the islanding of the *generating system* or cause a material reduction in power transfer capability by removing network elements from service.

Synchronous generating systems

(e) Subject to any changed power system conditions or energy source availability beyond the *Generator's* reasonable control, a *generating system* comprised of *synchronous generating units,* in respect of the types of fault described in subparagraphs (c)(2) to (4), must supply to or absorb from the *network*:

(1) to assist the maintenance of power system voltages during the fault, capacitive reactive current of at least the greater of its pre-disturbance reactive current and 4% of the maximum continuous current of the generating system including all operating synchronous *generating units* (in the absence of a disturbance) for each 1% reduction (from the level existing just prior to the fault) of *connection point* voltage during the fault;

(2) after clearance of the fault, reactive power sufficient to ensure that the *connection point* voltage is within the range for continuous uninterrupted operation under clause 3.3.5.4; and

(3) from 100 milliseconds after clearance of the fault, active power of at least 95% of the level existing just prior to the fault.

Asynchronous Generating Systems

(f) Subject to any changed power system conditions or energy source availability beyond the *Generator*'s reasonable control, a *generating system* comprised of asynchronous *generating units*, in respect of the types of fault described in subparagraphs (c)(2) to (4), must have facilities capable of supplying to or absorbing from the network:

(1) to assist the maintenance of power system voltages during the fault:

(i) capacitive reactive current in addition to its pre-disturbance level of at least 4% of the maximum continuous current of the *generating system* including all operating asynchronous *generating units* (in the absence of a disturbance) for each 1% reduction of voltage at the connection point below the relevant range in which a reactive current response must commence, as identified in subparagraph (g)(1), with the performance standards to record the required response agreed with the *Network Operator* and *Power System Controller*; and

(ii) inductive reactive current in addition to its pre-disturbance level of at least 6% of the maximum continuous current of the generating system including all operating asynchronous *generating units* (in the absence of a disturbance) for each 1% increase of voltage at the connection point above the relevant range in which a reactive current response must commence, as identified in subparagraph (g)(1), with the performance standards to record the required response agreed with the *Network Operator* and *Power System Controller*,

during the disturbance and maintained until connection point voltage recovers to between 90% and 110% of normal voltage, or such other range agreed with the *Network Operator* and *Power System Controller*, except for voltages below the relevant threshold identified in paragraph (h); and

(2) from 100 milliseconds after clearance of the fault, active power of at least 95% of the level existing just prior to the fault.

(g) For the purpose of paragraph (f):

(1) the *generating system* must commence a response when the voltage is in an under-voltage range of 85% to 90% or an over-voltage range of 110% to 115% of normal voltage. These ranges may be varied with the agreement of the *Network Operator* and *Power System Controller* (provided the magnitude of the range between the upper and lower bounds remains at Δ5%); and

(2) the reactive current response must have a rise time of no greater than 40 milliseconds and a settling time of no greater than 70 milliseconds and must be adequately damped.

(h) Despite paragraph (f), a generating system is not required to provide a capacitive reactive current response in accordance with subparagraph (f)(1)(i) where:

(1) the *generating system* is directly connected to the power system with no step-up or connection transformer; and

(2) voltage at the *connection point* is 5% or lower of normal voltage.

(i) Subject to paragraph (h), despite the amount of reactive current injected or absorbed during voltage disturbances, and subject to thermal limitations and energy source availability, a *generating system* must make available at all times:

(1) sufficient current to maintain rated apparent power of the *generating system* including all operating *generating units* (in the absence of a disturbance), for all *connection point* voltages above 115% (or otherwise, above the over-voltage range agreed in accordance with subparagraph (g)(1)); and

(2) the maximum continuous current of the *generating system* including all operating *generating units* (in the absence of a disturbance) for all *connection point* voltages below 85% (or otherwise, below the under-voltage range agreed in accordance with subparagraph (g)(1)),

except that the *Network Operator* and *Power System Controller* may agree limits on active current injection where required to maintain power system security and/or the quality of supply to other *Network Users*.

General requirement

All generating systems

(j) The performance standard must include any operational arrangements to ensure the *generating system* including all operating *generating units* will meet its agreed performance levels under abnormal network or *generating system* conditions.

(k) When assessing multiple disturbances, a fault that is re-established following operation of automatic reclose equipment shall be counted as a separate disturbance.

Asynchronous generating systems

(l) For the purpose of paragraph (f)-:

(1) the reactive current contribution may be limited to the maximum continuous current of a *generating system*, including its operating asynchronous *generating units*~~the reactive current contribution may be limited to 200% of the maximum continuous current of a generating system, including its operating asynchronous generating units;~~

(2) the reactive current contribution and *voltage* deviation described may be measured at a location other than the *connection point* (including within the relevant *generating system*) where agreed with the *Network Operator* and *Power System Controller*, in which case the level of injection and absorption will be assessed at that agreed location;

(3) the reactive current contribution required may be calculated using phase to phase, phase to ground or sequence components of *voltages*. The ratio of the negative sequence to positive sequence components of the reactive current contribution must be agreed with the *Network Operator* and *Power System Controller* for the types of disturbances listed in this clause 3.3.5.5; and

(4) the performance standards must record all conditions (which may include temperature) considered relevant by the *Network Operator* and *Power System Controller* under which the reactive current response is required.

Synchronous generating systems and units

(m) For a *generating system* comprised solely of synchronous *generating units*, the reactive current contribution may be limited to 250% of the maximum continuous current of the *generating system*.

(n) For a synchronous *generating unit* within a *generating system* (other than a *generating system* described in paragraph (m)), the reactive current contribution may be limited to 250% of the maximum continuous current of that synchronous *generating unit*.

3.3.5.6 Quality of Electricity Generated and Continuous Uninterrupted Operation

The automatic access standard is a *generating system* including each of its operating *generating units* and reactive plant, must not disconnect from the power system as a result of *voltage* fluctuation, harmonic *voltage* distortion and *voltage* unbalance conditions at the connection point within the levels specified in clauses 2.4.1, 2.4.2 and 2.4.3.

3.3.5.7 Partial Load Rejection

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

3.3.5.8 Protection of Generating Units from Power System Disturbances

(a) The automatic access standard is:

(1) subject to paragraph (d), for a *generating system* or any of its *generating units* that is required by a *Generator* or *Network Operator* to be automatically disconnected from the power system in response to abnormal conditions arising from the power system, the relevant protection system or control system must not disconnect the *generating system* for:

(i) conditions for which it must remain in continuous uninterrupted operation; or

(ii) conditions it must withstand under this Code.

(b) The *Network Operator* or *Power System Controller* may require that an access standard include a requirement for the *generating system* to be automatically disconnected by a local or remote control scheme whenever the part of the network to which it is connected has been disconnected, forming an island that supplies a ~~C~~*customer*.

(c) The access standard must include specification of conditions for which the *generating unit* or *generating system* must trip and must not trip.

(d) Notwithstanding clauses 3.3.5.3, 3.3.5.4, 3.3.5.5, 3.3.5.6 and 3.3.5.7, a *generating system* may be automatically disconnected from the power system under any of the following conditions:

(1) in accordance with an *ancillary services agreement* between the *Generator* and the *Network Operator* or *Power System Controller*;

(2) where a load that is not part of the *generating system* has the same *connection point* as the *generating system* and the *Network Operator* and *Power System Controller* agree that the disconnection would in effect be under-frequency load shedding;

(3) where the *generating system* is automatically disconnected under paragraph (a), clause 3.3.5.9 or by an emergency frequency control scheme;

(4) where the *generating system* is automatically disconnected under clause 3.3.5.10; or

(5) in accordance with an agreement between the *Generator* and the *Network Operator* (including an agreement in relation to an emergency control scheme under clause 2.6 to provide a service that is necessary to maintain or restore power system security in the event of a specified contingency event.)

(e) The *Network Operator* or *Power System Controller* is not liable for any loss or damage incurred by the *Generator* or any other person as a consequence of a fault on either the power system, or within the *Generator's facility*.

3.3.5.9 Protection Systems that Impact on Power System Security

(a) The automatic access standard is:

(1) primary protection systems must be provided to disconnect from the power system any faulted element in a *generating system* and in protection zones that include the connection point within the applicable fault clearance time determined under clause 2.9.4 and 2.9.5;

(2) each primary protection system must have sufficient redundancy to ensure that a faulted element within its protection zone is disconnected from the power system within the applicable fault clearance time with any single protection element (including any communications facility upon which that protection system depends) out of service; and

(3) breaker fail protection systems must be provided to clear faults that are not cleared by the circuit breakers controlled by the primary protection system within the applicable fault clearance time determined under clause 2.9.4 and 2.9.5

(b) In relation to an automatic access standard under this clause 3.3.5.9, the ~~Generator~~*Generator* must provide redundancy in the primary protection systems under paragraph (a)(2) and provide breaker fail protection systems under paragraph (a)(3) if the *Network Operator* and *Power System Controller* consider that a lack of these facilities could result in:

(1) a material adverse impact on power system security or quality of supply to other *Network Users*; or

(2) a reduction in intra-regional power transfer capability,

through any mechanism including:

(3) consequential tripping of, or damage to, other network equipment or facilities of other *Network Users*, that would have a power system security impact; or

(4) instability that would not be detected by other protection systems in the network.

(c) The *Network Operator* and the ~~Generator~~*Generator* must cooperate in the design and implementation of protection systems to comply with this clause 3.3.5.9, including cooperation on:

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

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

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

(d) The protection system design referred to in paragraphs (a) must:

(1) be coordinated with other protection systems;

(2) avoid consequential disconnection of other *Network Users'* facilities; and

(3) take into account existing obligations of the *Network Operator* under *connection agreements* with other *Network Users*.

3.3.5.10 Protection to Trip Plant for Unstable Operation

(a) The automatic access standard is a generating system must have:

(1) for its synchronous generating units, a protection system to disconnect it promptly when a condition that would lead to pole slipping is detected, to prevent pole slipping or other conditions where a generating unit causes active power, reactive power or voltage at the connection point to become unstable as assessed in accordance with the power system stability guidelines established under clause 16; and

(2) for its asynchronous generating units, a protection system to disconnect it promptly for conditions where the active power, reactive power or voltage at the connection point becomes unstable as assessed in accordance with the guidelines for power system stability established under clause 16.

3.3.5.11 Frequency Control

(a) For the purpose of this clause 3.3.5.11:

Droop means, in relation to frequency response mode, the percentage change in power system frequency as measured at the connection point, divided by the percentage change in power transfer of the generating system expressed as a percentage of the maximum operating level of the generating system. Droop must be measured at frequencies that are outside the deadband and within the limits of power transfer.

(b) The automatic access standard is:

(1) a *generating system's* power transfer to the power system must not:

(i) increase in response to a rise in the frequency of the power system as measured at the connection point; or

(ii) decrease in response to a fall in the frequency of the power system as measured at the connection point; and

(2) a *generating system* must be capable of operating in frequency response mode such that it automatically provides a proportional:

(i) decrease in power transfer to the power system in response to a rise in the frequency of the power system as measured at the connection point; and

(ii) increase in power transfer to the power system in response to a fall in the frequency of the power system as measured at the connection point,

sufficiently rapidly and sustained for a sufficient period for the *Generator* to be in a position to offer measurable amounts of all ancillary services for the provision of power system frequency control.

(c) Each control system used to satisfy this clause 3.3.5.11 must be adequately damped.

(d) The amount of a relevant market ancillary service for which the plant may be registered must not exceed the amount that would be consistent with the performance standard registered in respect of this requirement.

(e) For the purposes of subparagraph (b)(2):

(1) the change in power transfer to the power system must occur with no delay beyond that required for stable operation, or inherent in the plant controls, once the frequency of the power system as measured at the connection point leaves a deadband around 50 Hz;

(2) a generating system must be capable of setting the deadband and droop within the following ranges:

(i) the deadband referred to in subparagraph (1) must be set within the range of 0 to ± 1.0 Hz. Different deadband settings may be applied for a rise or fall in the frequency of the power system as measured at the connection point; and

(ii) the droop must be settable within the range of 1% to 6%, or such other settings as agreed with the *Network Operator* and *Power System Controller*;

(3) nothing in subparagraph (b)(2) is taken to require a *generating system* to operate below its minimum operating level in response to a rise in the frequency of the power system as measured at the connection point, or above its maximum operating level in response to a fall in the frequency of the power system as measured at the connection point; and

(4) the performance standards must record:

(i) agreed values for maximum operating level and minimum operating level, and where relevant the method of determining the values, and the values for a generating system must take into account its in-service generating units; and

(ii) for the purpose of subparagraph (b)(2), the market ancillary services, including the performance parameters and requirements that apply to each such market ancillary service.

3.3.5.12 Impact on Network Capability

(a) The automatic access standard is a *generating system* must have plant capabilities and control systems that are sufficient so that when connected it does not reduce any intra-regional power transfer capability below the level that would apply if the *generating system* were not connected.

3.3.5.13 Voltage and Reactive Power Control

(a) The voltage and reactive power control automatic access standard is:

(1) The *excitation control system* of a *synchronous generating unit* shall be capable of:

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

(ii) controlling the *generating unit* output to maintain the short-time average ~~*Generation Unit*~~*generating unit* output voltage at highest rated level (which shall be at least 5% above the nominal output voltage and is usually 10% above the nominal output voltage);

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

(iv) in the case of a rotating synchronous generator, the five second ceiling excitation voltage shall be at least twice the excitation voltage required to achieve maximum continuous rating at nominal voltage; and

(v) providing reactive current compensation settable for boost or droop unless otherwise agreed by the *Network Operator*.

(2) The excitation control system of a ~~*synchronous*~~ *generating unit* shall be capable of:

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

(ii) New non-synchronous *generating units* must be fitted with fast acting voltage and / or reactive power control systems, which must utilise modern technology and be approved by the *Network Operator*. Control systems must provide regulation to within 0.5% of the selected set point value.

(iii) Unless agreed by the *Network Operator*, new synchronous *generating units* shall incorporate power system stabiliser circuits that modulate *generating unit* field voltage in response to changes in power output and/or shaft speed and/or any other equivalent input signal approved by the *Network Operator*. The stabilising circuits shall be responsive and adjustable over a frequency range that shall include frequencies from 0.1 Hz to 2.5 Hz.

(iv) The *Network Operator* may require power system stabiliser circuits on synchronous *generating units* with ratings less than or equal to 10 MW or smaller synchronous *generating units* within a power station with a total active power output capability less than or equal to 10 MW (if power system simulations indicate a need for such a requirement). Before commissioning of any power system stabiliser, the *Generator* must propose preliminary settings for the power system stabiliser, which must be approved by the *Network Operator*.

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

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

(vii) The performance characteristics set out in Figure 7 are required for AC exciter, rotating rectifier and static excitation systems.

Figure 7 – *Synchronous Generator* excitation system performance requirements

Performance Item	**Units**	**Static Excitation**	**A.C. Exciter or Rotating Rectifier**	**Notes**
***Sensitivity*:** A sustained 0.5% error between the *voltage* reference and the sensed *voltage* will produce an excitation *change* of not less than 1.0 per unit.	Open loop gain (ratio)	200 minimum	200 minimum	1
Field *voltage* rise *time*: *Time* for field *voltage* to rise from rated *voltage* to excitation ceiling *voltage* following the application of a short duration impulse to the *voltage* reference.	second	0.05 maximum	0.5 maximum	2
Settling *time* with the *Generator synchronised* following a disturbance equivalent to a 5% step *change* in the sensed *Generator* terminal *voltage*.	second	2.5 maximum	5 maximum	3
Settling *time* with the *Generator unsynchronised* following a disturbance equivalent to a 5% step *change* in the sensed *Generator* terminal *voltage*. Shall be met at all operating points within the *Generator* capability.	second	1.5 maximum	2.5 maximum	3
Settling *time* following any disturbance that causes an excitation limiter to operate.	second	5 maximum	5 maximum	3

Notes:

1. One per unit is that field *voltage* required to produce nominal *voltage* on the air gap line of the *Generator* open circuit characteristic (Refer IEEE Standard 115-1983 – Test Procedures for Synchronous Machines).
2. Rated field *voltage* is that *voltage* required to give nominal *Generator* terminal *voltage* when the *Generator* is operating at its maximum continuous rating. Rise *time* is defined as the *time* taken for the field voltage to rise from 10% to 90% of the increment value.
3. Settling time is defined as the time taken for the Generator terminal voltage to settle and stay within an error band of ±10% of its increment value.

(viii) The performance characteristics required for the voltage or reactive power control systems of all non-synchronous *generating units* ~~Generation Units~~ are specified in Figure 8.

Figure 8 – *Non-synchronous Generator voltage* or *reactive power* control *system* performance requirements

Performance Item	**Units**	**Limiting Value**	**Notes**
***Sensitivity*:** A sustained 0.5% error between the reference *voltage* and the sensed *voltage* must produce an output change of not less than 100% of the *reactive power generation* capability of the generating unit~~*Generation Unit*~~, measured at the point of control.	Open loop gain (ratio)	200 minimum	1
Rise time: Time for the controlled parameter (*voltage* or *reactive power* output) to rise from the initial value to 90% of the change between the initial value and the final value following the application of a 5% step change to the *control system* reference.	second	1.5 maximum	2
Small disturbance settling time Settling time of the controlled parameter with the *generating unit*~~*Generation Unit*~~ connected to the *transmission or distribution network* following a step change in the *control system* reference that is not large enough to cause saturation of the controlled output parameter. Must be met at all operating points within the *generating unit*~~*Generation Unit*~~'s capability.	second	2.5 maximum	3
Large disturbance settling time Settling time of the controlled parameter following a large disturbance, including a *transmission or distribution network* fault, which would cause the maximum value of the controlled output parameter to be just exceeded.	second	5 maximum	3

Notes:

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

(ix) The *Network Operator* shall approve the structure and parameter settings of all components of the excitation control system, including the voltage regulator, power system stabiliser, power amplifiers and all excitation limiters.

~~(i)~~(x) The structure and settings of the excitation control system shall not be changed, corrected or adjusted in any manner without prior written notification to the *Network Operator*. The *Network Operator* may require *generating unit*~~Generation Unit~~ tests to demonstrate compliance with the requirements of Figure 7 or Figure 8. The *Network Operator* may witness such tests.

(xi) Settings may require alteration from time to time as advised by the *Network Operator or Power System Controller*. The cost of altering the settings and verifying subsequent performance shall be borne by the User, provided alterations are not made more than once in each 18 months for each *generating unit*~~Generation Unit~~. If more frequent changes are requested the person making that request shall pay all costs on that occasion.

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

3.3.5.14 Active Power Control

(a) The active power control automatic access standard is a *generating system* must have an active power control system capable of:

(1) For a scheduled generating unit or scheduled generating system:

(i) Maintaining and changing its active power output in accordance with its dispatch instructions; and

~~Ramping its active power output linearly at a rate not less than 5% of nameplate rating per minute; and~~

(ii) Receiving and automatically responding to AGC signals as updated (nominal update rate of once per four seconds)

(b) Each control system used to satisfy the requirements of paragraph (a) must be adequately damped.

(c) Settings may require alteration from time to time as advised by the *Network Operator or Power System Controller*. The cost of altering the settings and verifying subsequent performance shall be borne by the User, provided alterations are not made more than once in each 18 months for each *generating unit*. If more frequent changes are requested the person making that request shall pay all costs on that occasion.

(d) A *generating system* must be capable of ramping its active power output linearly at a rate not slower than 5% of nameplate rating per minute.

3.3.5.15 Inertia and Contingency FCAS

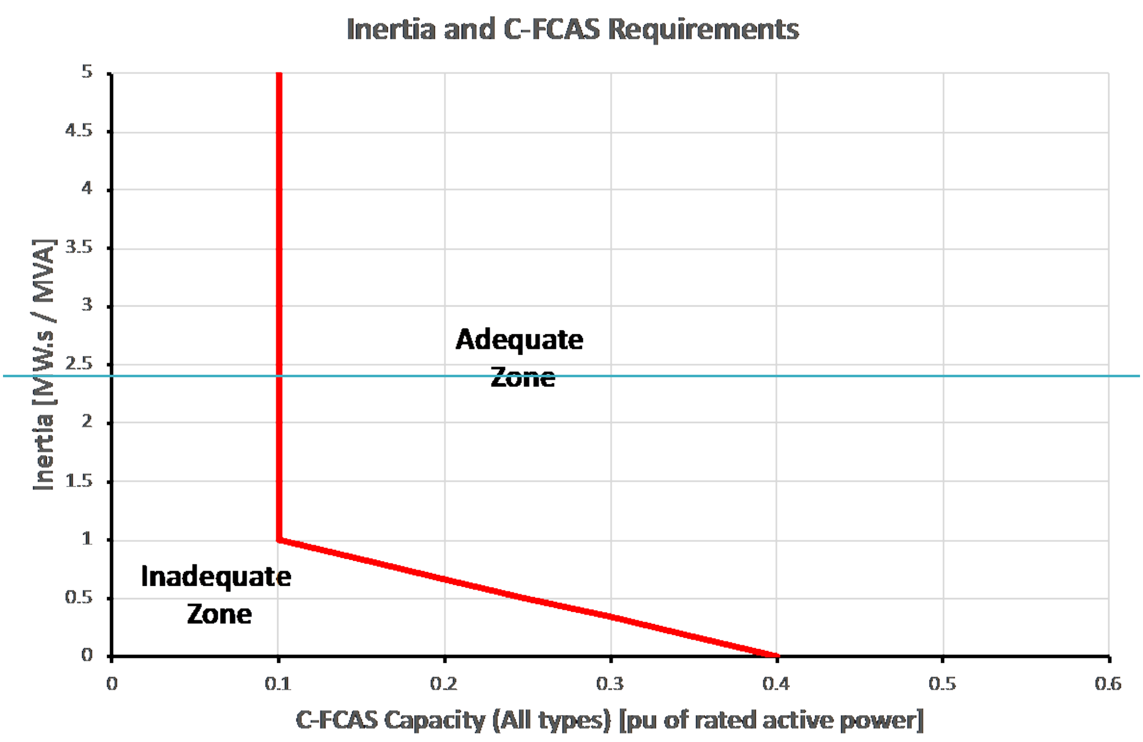
(a) The *inertia* and *contingency FCAS* automatic access standard is:

(1) A *generat~~o~~ring system* must have an adequate *inertia* and ~~C~~*contingency FCAS* capability as defined by the characteristic below. The capability must be able to be dispatched up to a point within the adequate zone as shown, and can be achieved by any combination of partially loaded *generat~~o~~ring unit(s)*, and/or additional plant (e.g. synchronous condensers, energy storage system, etc), to achieve the required capability.

(2) *Inertia* offered or provided from non-synchronous (emulated) sources needs to be assessed and accepted by the *Power System Controller* and *Network Operator*.

(3) The *inertia* and *FCAS* capabilities will be accredited by the *Power System Controller* using the specifications and evaluation framework outlined in the System Secure Guidelines.

Figure 9 – Inertia vs C-FCAS Trade Off Requirements for New Generators



3.3.5.16 System Strength

(a) The system strength automatic access standard is a *generating system* must not cause an adverse impact on system strength as defined in the AEMO System Strength Impact Assessment Guidelines v1.0 July 2018 and following an assessment by the *Network Operator*.

Subject to paragraph (a),

(1) a *Network Operator* must undertake system strength connection works at the cost of the connection applicant if the full assessment undertaken in accordance with the AEMO system strength impact assessment guidelines indicates that the connection applicant's proposed new connection of a generating facility or the *Generator*'s proposed alteration to a generating system will have an adverse system strength impact, or

(2) to the extent that the adverse system strength impact referred to in paragraph (a) is or will be avoided or remedied by a system strength remediation scheme agreed or determined under this clause and implemented by the connection applicant in accordance with its *connection agreement*.

(i) A connection applicant proposing to install plant as part of a system strength remediation scheme must include a description of the plant, the ratings of the proposed plant (in MVA) and other information (including models) reasonably required by the *Network Operator* and *Power System Controller* to assess the system strength remediation scheme.

3.3.5.17 Capacity Forecasting

(a) In this clause 3.3.5.17, the following terms apply:

(1) 't' is time.

(2) 't=0' refers to the moment when a forecast is updated.

(3) 't=[numeral]' refers to the number of minutes elapsed since t=0.

(4) 'capacity' means the minimum capability of a *generating system* to deliver an active power output at a continuous steady level over the relevant 5 minute interval.

(5) 'firm offer' means the capacity forecast provided at t=0 for the interval commencing t=0 for 5 minutes

(6) 'dispatch capacity' means the capacity instructed to the *Generator* to be injected into the grid.

(7) 'actual capacity' means the minimum instantaneous power injected into the grid for the interval commencing t=0 for 5 minutes.

(b) The capacity forecasting automatic access standard is:

(1) A *Generator* must supply to the *Power System Controller* a forward forecast of the capacity of its *generating system*.

(2) The forecast in 3.3.5.17(b)(1) must:

(i) include a 24 hour ahead forecast for capacity for every 5 minute interval, updated at 5 minute intervals; and

(ii) have an accuracy such that in any rolling 24 hour period at 90% of the non-zero forecasts for the intervals commencing from t=5 to t= 30 do not exceed the firm offer for the time for which the forecast was made.

(3) For the 10% of forecast updates that do not meet paragraph (2)(ii) above, the forecast must not exceed the firm offer by a margin greater than:

(i) 5% of the *generating unit's* nameplate rating; or

(ii) 1 MW,

whichever is the lesser.

(4) The actual capacity must be within +/- 0.5% of the dispatch capacity.

Note: When issuing dispatch instructions, the System Controller will respect plant limits such as firm offers and ramp rates of plant.

(c) A *Generator* must provide forecasts to the *Power System Controller* in a format specified by the *Power System Controller*.

(d) The *generating system* owner will be required to report compliance against the above requirements in a format and timeframe determined by the *Power System Controller*.

(e) In the event of non-compliance with the automatic access standard by a *Generator*, the *Power System Controller* may adjust that *Generator's* subsequent forecasts and firm offers accordingly.

3.3.6 Monitoring and Control Requirements

3.3.6.1 Remote Monitoring and Control

(a) The remote monitoring standard is:

(1) The *Network Operator* will require users to provide remote monitoring equipment ("RME") to enable the *Network Operator* and the *Power System Controller* to remotely monitor performance of a *generating unit* ~~Generation Unit~~ (including its dynamic performance) where this is

reasonably necessary in real time for control, planning or security of the power system; and

(2) Any RME provided, upgraded, modified or replaced (as applicable) shall conform to an acceptable standard as agreed by the *Network Operator* and shall be compatible with the *Network Operator*'s SCADA system and the nomenclature standards of the *Network Operator* and as agreed to by the *Power System Controller*

(3) Input information to RME may include, but not be limited to, the following:

(i) Status indications:

a. Generati~~on~~ng Unit Circuit Breaker Open/Closed
b. Remote Generation Load Control on/off
c. Generating Unit Operating Mode
d. Governor Limiting Operation
e. Connection to the network

(ii) Alarms:

a. Generati~~on~~ng Unit Circuit Breaker Tripped by Protection
b. Prepare to off load

(iii) Protection Defective Alarms

(iv) Measure Values:

a. Gross active power output of each *generating unit* ~~Generation Unit~~
b. Net station active power import or export at each connection point
c. Gross reactive power output of each *generating unit* ~~Generation Unit~~
d. Net station reactive power import or export at each connection point
e. *Generati~~on~~ng u~~U~~nit* stator voltage
f. *Generating unit* ~~*Generation Unit*~~ transformer tap position
g. Net station output of active energy (impulse)
h. *Generating unit* ~~*Generation Unit*~~ remote *Generation* control high limit value
i. *Generating unit* ~~*Generation Unit*~~ remote *Generation* control low limit value
j. *Generating unit* ~~*Generation Unit*~~ remote *Generation* control rate limit value
k. For energy storage devices the available energy (in MWh)
l. *Generating unit* ~~*Generation Unit*~~ present maximum active capacity~~bility~~

m. *Generating unit* ~~*Generation Unit*~~ forecasted maximum active capacity~~bility~~

(v) Such other input information reasonably required by the *Network Operator or Power System Controller*.

(4) A User is required to install remote control equipment (“RCE”) that is adequate to enable the *Power System Controller* to remotely control:

(i) The active power output of any *generating unit*~~*Generation Unit*~~; and

(ii) The reactive power output of any *generating unit*~~*Generation Unit*~~.

(5) Unless agreed otherwise, the relevant User will be responsible for the following actions at the request of the *Network Operator* or the *Power System Controller*:

(i) Activating and de-activating RCE installed in relation to any *generating unit*~~Generation Unit~~; and

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

(6) A User shall provide electricity supplies for the RME and RCE installed in relation to its *generating unit* ~~Generation Unit~~ 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*~~Generation Unit~~.

(7) The performance of the RME and RCE in terms of accuracy and reliability shall meet the requirements of the *Network Operator* and *Power System Controller*.

3.3.6.2 Communications Equipment

(a) The communications equipment standard is:

(1) A User shall provide communications paths (with appropriate redundancy) between RME or RCE installed at any of its ~~Generation Units~~*generating units* to a communications interface at the relevant power station and in a location reasonably acceptable to the *Network Operator*.

(2) Communications systems between this communications interface and the relevant control centre shall be the responsibility of the *Network Operator* unless otherwise agreed,

(3) The User shall meet the cost of the communications systems, unless otherwise determined by the *Network Operator*.

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

(i) Primary Speech Facility

(A) Each User shall provide and maintain equipment by means of which routine and emergency control telephone calls may be established between the User's responsible Engineer/ Operator and the *Power System Controller*.

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

(ii) Back-up Speech Facility

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

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

3.3.7 Power Station Auxiliary Supplies

In cases where a generating system takes its auxiliary supplies via a connection point through which its generation is not transferred to the network, the access standards for the auxiliaries must be established under clause 3.6 as a Load Customer.

3.3.8 Fault Current

(a) The fault current standard is:

(1) The contribution of the generating system to the fault current on the connecting network through its connection point must not exceed the contribution level that will ensure that the total fault current can be safely interrupted by the circuit breakers of the connecting network and safely carried by the connecting network for the duration of the applicable breaker fail protection system fault clearance times, as specified for the relevant connection point by the *Network Operator*;

(2) A generating system's connected plant must be capable of withstanding fault current through the connection point up to the higher of:

(i) The level specified by the *Network Operator*; or

(ii) The highest level of current at the connection point that can be safely interrupted by the circuit breakers of the connecting network and safely carried by the connecting network for the duration of the applicable breaker fail protection system fault clearance times, as specified by the *Network Operator*.

(3) A circuit breaker provided to isolate a generating unit or generating system from the network must be capable of breaking, without damage or restrike, the maximum fault currents that could reasonably be expected to flow through the circuit breaker for any fault in the network or in the generating unit or generating system, as specified in the *connection agreement*.

~~(a) The *Network Operator* will carry out detailed *power system* studies to determine performance requirements to be expected from a proposed new *Generation Unit* or modification to an existing *Generation Unit*.~~

~~(b) All costs associated with these studies, including studies to obtain any necessary optimal settings for the *Generation Unit* and its controls shall be borne by the *User*.~~

~~(c) 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.~~

~~(d) *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 (eg. increasing fault levels as additional *plant* is *connected* to the *power system*).~~

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

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

~~**3.1.13 *Protection* requirements**~~

~~(a) *Protection* of a *Generator* shall generally be at the discretion of the *User*, but shall be sufficient to protect the *Generator* from faults on the *Network Operator power system*.~~

~~(b) *Protection* of a *Generator* will be by *two fully independent protection schemes of differing principle*, each one discriminating with the *protection schemes* used on the *Network Operator power system*.~~

~~(c) Where a *critical fault clearance time* exists, each *protection* shall be capable of meeting the *critical fault clearance time*.~~

~~(d) *Generator protection schemes* are to meet the *fault clearance times* specified in clause 2.9.5.~~

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

~~(1) Separation of the *User's Generation Plant* from the *Network Operator power system* in the event of any of the above *protection schemes* operating.~~

~~(2) Separation of the *User's Generation Plant* from the *Network Operator power system* in the event of loss of *supply* to the *User's* installation from the *Network Operator's power system*.~~

~~(3) Prevention of the *User's Generation Plant* from energising de-*energised Network Operator plant*, or energising and *supplying* an otherwise isolated portion of the *Network Operator's power system*.~~

~~(4) Adequate *protection* of the *User's* equipment and complete installation without reliance on back up from the *Network Operator's protection*.~~

~~3.1.13.1 Check *synchronising*~~

~~(a) 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.~~

~~(b) Distinction should be drawn between check *synchronising* interlocks and *synchronising* facilities (refer to clause 3.3.5).~~

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

~~(d) In addition, the check *synchronising* interlocks shall be installed on all *Users'* circuit breakers capable of out-of-synchronism closure, unless otherwise interlocked.~~

~~3.1.14 Technical characteristics~~

~~(a) If required by the *Network Operator* a *User* shall provide *power system* stabilising facilities on each *synchronous Generation Unit* if *power system* simulations indicate such a requirement.~~

~~(b) If required by the *Network Operator*, a *User* shall ensure that new *synchronous Generation Units* have a short circuit ratio of not less than 0.5 if necessary to limit the reduction in *power transfer* capabilities that are determined by transient stability considerations.~~

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

~~(d) A *User* shall ensure that its *Generation Unit*(s) satisfy the *Network Operator's* reasonable requirements to ensure stability of the *electricity network* and maintain *power transfer* capabilities. These requirements will have an impact on the *Generator*, governor and excitation system parameters, including the inertia constant, of the *Generation Unit*.~~

~~(e) The technical requirements described in this clause 3.3.2 are required to be demonstrated by the methods described in clause 5.4 of this *Code*.~~

~~*3.1.14.1 Reactive power capability*~~

~~(a) Each *Generation Unit*, and the *power station* in which the *Generation Unit* is located, shall be capable of continuously providing its full *reactive power output* within the full range of steady state *voltages* at the *connection point* permitted under clause 2 and clause 15.2 of the *Network Planning Criteria*.~~

~~(b) Unless otherwise agreed by the *Network Operator*:~~

~~(1) Each synchronous *Generation Unit*, while operating at any level of active power output between its registered maximum and minimum active power output level, shall be capable of:~~

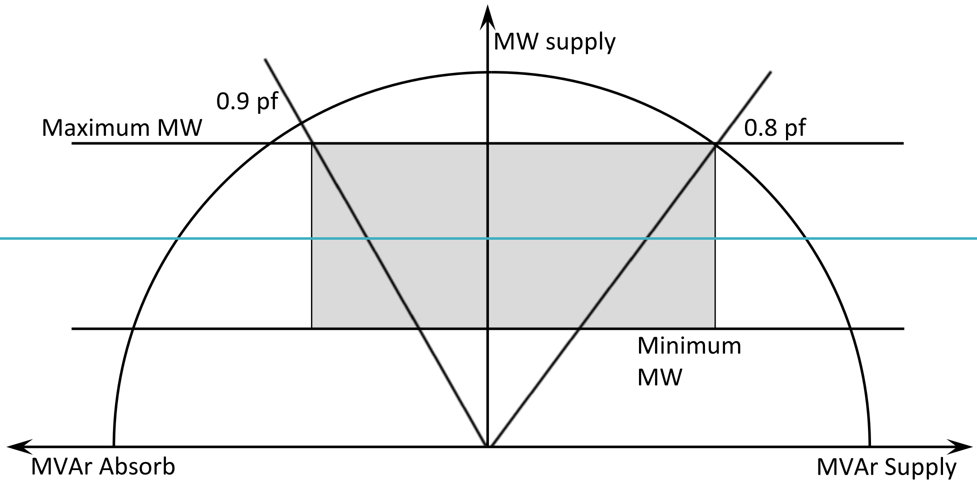
~~(i) *supplying* at its generator machine's terminals an amount of reactive power of at least the amount equal to the product of the rated active power output of the *Generation Unit* at nominal voltage and 0.750; and~~

~~(ii) absorbing at its generator machine's terminals an amount of reactive power of at least the amount equal to the product of the rated active power output of the *Generation Unit* at nominal voltage and 0.484.~~

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

~~These details are displayed in Figure 1. The minimum *reactive power* capability requirement is shown shaded.~~

~~**Figure 1 – Synchronous *Generation Unit reactive power* capability**~~

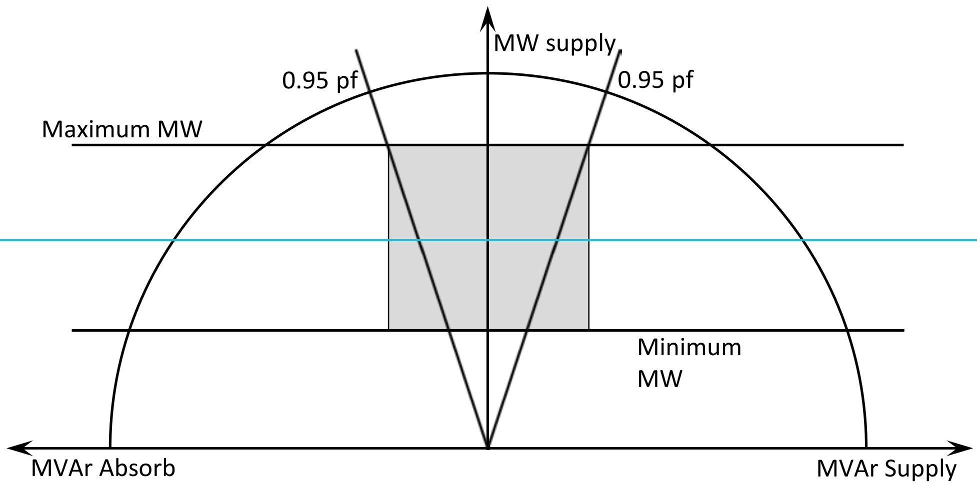


~~(2) Each induction *Generation Unit*, while operating at any level of active power output between its registered maximum and minimum output level, shall be capable of *supplying* or absorbing an amount of reactive power at the *connection point* of at least the amount equal to the product of the rated active power output of the *Generation Unit* at nominal voltage and 0.329.~~

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

~~These details are displayed in Figure 2. The minimum *reactive power* capability requirement is shown shaded.~~

~~**Figure 2 - Induction *Generation Unit reactive power* capability**~~

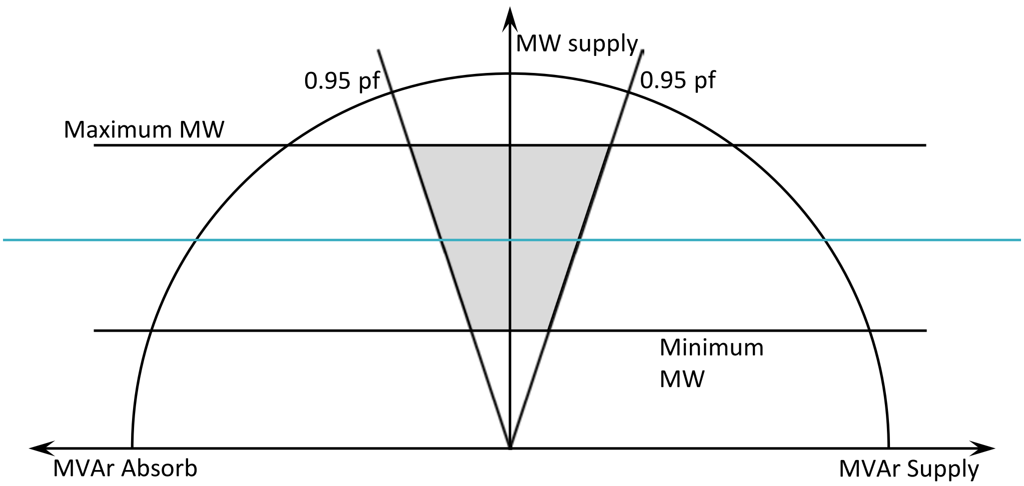


~~(3) Where necessary to meet the performance standards specified in clause 2, the *Network Operator* may require an induction *Generation Unit* to be capable of *supplying* or absorbing a greater amount of *reactive power* output than specified in clause 3.3.2.1(b)(2). The need for such a requirement will be determined by power system simulation studies and any such a requirement shall be included in the *Access Agreement*.~~

~~(4) Each inverter coupled *Generation Unit* or converter coupled *Generation Unit*, while operating at any level of active power output between its registered maximum and minimum output level, shall be capable of *supplying* reactive power such that at the inverter or converter *connection point* the lagging power factor is less than or equal to 0.95 and shall be capable of absorbing reactive power at a leading power factor less than or equal to 0.95.~~

~~These details are displayed in Figure 3. The minimum *reactive power* capability requirement is shown shaded.~~

~~**Figure 3 – Invertor coupled *Generation Unit reactive power* capability**~~



~~(5) Where necessary to meet the requirements of the *Code*, the *Network Operator* may require an inverter *Generation Unit* to be capable of *supplying a reactive power* output coincident with rated *active power* output over a larger *power factor* range. The need for such a requirement will be determined by power system simulation studies and any such a requirement shall be included in the *Access Agreement*.~~

~~(c) For *Generation Units* not described by clause 3.3.2.1(b), the *power factor* requirements shall be as advised by the *Network Operator* and included in the *Access Agreement*. In determining the appropriate *power factor* requirement, the *Network Operator* shall consider the intrinsic capabilities of such a new technology and the potential for its penetration.~~

~~(d) If the *power factor* capabilities specified in clause 3.3.2.1(b) cannot be provided, the *Generator* shall reach an arrangement under the *Access*~~

~~*Agreement* with the *Network Operator* for the supply of the deficit in *reactive power* at the *connection point*. The basis for negotiation will be the responsibility of the proponent to provide an equivalent reactive performance (MVAr output) over a range of voltages at the *connection point*.~~

> ~~Clause 3.3.2.1(d) is intended to facilitate flexibility in design by assisting proponents to connect *Generation Units* that, of themselves, are not capable of meeting the *reactive power generation* requirements specified in clause 3.3.2.1(b) through providing for the shortfall to be made up through some other means.~~

~~(e) Each *Generation Unit*'s connection shall be designed to permit the *dispatch* of the full *active power* and *reactive power* capability of the facility as specified in the *Access Agreement* under all power system conditions contained in clause 2.~~

~~3.1.14.2 Quality of electricity *generated*~~

~~(a) When operating *unsynchronised*, a *synchronous Generation Unit* shall generate a constant *voltage* level with balanced phase *voltages* and harmonic *voltage* distortion equal to or less than permitted in accordance with either Australian Standard AS/NZS 1359.102.3:2000 "Rotating Electrical Machines – General Requirements" or a recognised equivalent international standard, as agreed between the *Network Operator* and the *User*.~~

~~(b) For non-*synchronous Generators* the contributions to *quality of supply* shall be not less than that required to be provided by *Users* as defined in clause 2.4.~~

~~3.1.14.3 *Generation Unit* response to disturbances in the *power system*~~

~~The following are design requirements for *Generation Units*. *Network* performance requirements are detailed in clause 2 of this *Code*.~~

~~(a) A *Generation Unit*, and the *power station* in which the *Generation Unit* is located, shall be capable of continuous uninterrupted operation within the *frequency* limits specified in clause 2.2.~~

~~(b) Subject to clause 3.3.2.3(b) a *Generation Unit*, and the *power station* in which the *Generation Unit* is located, shall be capable of continuous uninterrupted operation during the occurrence of the range of *voltage* variation conditions permitted by clause 2.3, including the *voltage* dip caused by a *network* fault which causes *voltage* at the *connection point* to drop to zero for up to 500 milliseconds in any one phase or combination of phases, followed by a period of ten seconds where *voltage* may vary in the range 80-110% of the nominal *voltage*, and a subsequent period of three minutes in which the *voltage* may vary within the range 90-110% of the nominal *voltage*.~~

~~(c) The *Network Operator* may agree to vary the requirements of clause 3.3.2.3(b) provided that it is satisfied that the *Network* performance standards of clause 2 of the *Code* and the *system* stability requirements of clause 16 of the *Network Planning Criteria* would be met.~~

~~3.1.14.4 Partial *load* rejection~~

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

~~3.1.14.5 *Loading* rates~~

~~A *scheduled Generation Unit* shall be capable of increasing or decreasing *load* in response to a manually or remotely initiated *loading* order at a rate not less than 5% of *nameplate rating* per minute or as otherwise agreed between the *Network Operator* and the relevant *User*, stated in their *Access Agreement*.~~

~~3.1.14.6 Safe shutdown without external electricity *supply*~~

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

~~3.1.14.7 Restart following restoration of external electricity *supply*~~

~~(a) If reasonably required by the *Network Operator*, a *Generation Unit* shall be capable of being restarted and *synchronised* to the *power system* without unreasonable delay following restoration of external *supply* from the *network power system* at the relevant *connection point*, after being without external *supply* for two hours or less, provided that the *Generation Unit* was *disconnect*ed for any reason other than a fault within the *Generation Unit*.~~

~~(b) Examples of unreasonable delay in the restart of a *Generation Unit* are:~~

~~(1) delays not inherent in the design of the relevant start-up facilities and which could reasonably have been eliminated by the relevant *User*; and~~

~~(2) the start-up facilities for a new *Generation Unit* not being designed to minimise start up *time* delays for the *Generation Unit* following loss of external supplies for two hours or less.~~

~~3.1.14.8 *Protection* of *Generation Units* from *power system* disturbances~~

~~(a) A *Generation Unit* shall be automatically *disconnect*ed from the *power system* in response to conditions at the relevant *connection point* that are not within the agreed engineering limits for operating the *Generation Unit* or where the conditions may impact on other *Users*. If reasonably required by the *Network Operator*, these abnormal conditions will include and are not necessarily limited to:~~

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

~~(2) sustained high or low *frequency* outside the *power system frequency* range 47 Hz to 52 Hz (in the case of operation below 47 Hz but at or above 45 Hz, all *Generators* shall remain *connected* to the *Network Operator's network* for a period of at least two seconds - refer to clause 2.2.2);~~

~~(3) sustained excessive *Generation Unit* stator current that cannot be automatically controlled;~~

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

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

~~(6) excessive negative phase sequence current;~~

~~(7) loss of excitation; and~~

~~(8) reverse power.~~

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

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

~~3.1.14.9 *Users' protection systems* that impact on *power system security*~~

~~Refer to clause 3.2.3 for the requirements of *protection systems* for *Users' plant*. The requirements of clause 3.2.3 apply only to *protection* that is necessary to maintain *power system security*. *Protection* solely for *User* risks is at the *User's* discretion.~~

~~3.1.14.10 *Generator transformer* tapping~~

~~Unless otherwise agreed between the *Network Operator* and the *User*, the *Generator transformer* of a *Generation Unit* shall be capable of off-*load* tap-changing within the range specified in the relevant *Access Agreement*.~~

~~3.1.14.11 Tripping of *Generation Units* and *associated loads*~~

~~Unless otherwise agreed by the *Network Operator*, the tripping of a *User's Generation Unit* which is *connected* to the *network* will require the intertripping of *associated loads* within 0.2 seconds unless the *loads* are the subject of an *Access Agreement* with the *Network Operator* and the *User* has contracted for the provision of *standby power* and that *standby power* is available at the *time* of the tripping of the *Generation Unit*.~~

~~3.1.15 Monitoring and control requirements~~

~~3.1.15.1 Remote monitoring~~

~~The *Network Operator* will require the *Users* to:~~

~~(a) Provide *remote monitoring equipment* (*"RME"*) to enable the *Network Operator* and the *Power System Controller* to remotely monitor performance of a *Generation Unit* (including its *dynamic performance*) where this is reasonably necessary in real *time* for control, planning or security of the *power system*; and~~

~~(b) Upgrade, modify or replace any *RME* already installed in a *power station* provided that the existing *RME* is, in the reasonable opinion of the *Network Operator*, no longer fit for purpose and notice is given in writing to the relevant *Users*.~~

~~(c) In clause 3.3.3.1(a) and 3.3.3.1 (b), the *RME* provided, upgraded, modified or replaced (as applicable) shall conform to an acceptable standard as agreed by the *Network Operator* and shall be compatible with the *Network Operator's SCADA system*, including the requirements of clause 4.9 of this *Code*.~~

~~(d) Input information to *RME* may include, but not be limited to, the following:~~

~~(1) Status Indications~~

~~(i) *Generation Unit* circuit breaker open/closed (double pole)~~

~~(ii) remote *Generation load* control on/off~~

~~(iii) *Generation Unit* operating mode~~

~~(iv) governor limiting operation~~

~~(v) *connection* to the *network*~~

~~(2) Alarms~~

~~(i) *Generation Unit* circuit breaker tripped by *protection*~~

~~(ii) prepare to off *load*~~

~~(3) *Protection* Defective Alarms~~

~~(4) Measured Values~~

~~(i) Gross *active power* output of each *Generation Unit*~~

~~(ii) Net station *active power* import or export at each *connection point*~~

~~(iii) Gross *reactive power* output of each *Generation Unit*~~

~~(iv) Net station *reactive power* import or export at each *connection point*~~

~~(v) *Generation Unit* stator *voltage*~~

~~(vi) *Generation Unit transformer tap position*~~

~~(vii) Net station output of *active energy* (impulse)~~

~~(viii) *Generation Unit* remote *Generation* control high limit value~~

~~(ix) *Generation Unit* remote *Generation* control low limit value~~

~~(x) *Generation Unit* remote *Generation* control rate limit value~~

~~(5) Such other input information reasonably required by the *Network Operator*.~~

~~3.1.15.2 Remote control~~

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

~~(1) the *active power* output of any *Generation Unit*; and~~

~~(2) the *reactive power* output of any *Generation Unit*;~~

~~in a system emergency.~~

~~(b) Where a *User* does not provide *RCE*, the *User* shall satisfy the *Network Operator* and the *Power System Controller* that adequate arrangements are in place to allow the *Power System Controller* to give *directions* to the *User* for the control of the *Users' Generation Units* in a system emergency, and to allow the *User* to respond appropriately to those *directions*. These arrangements shall include the control of *active power* and *reactive power*.~~

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

~~(1) activating and de-activating *RCE* installed in relation to any *Generation Unit*; and~~

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

~~3.1.15.3 Communications equipment~~

~~(a) A *User* shall provide electricity supplies for the *RME* and *RCE* installed in relation to its *Generation Units* capable of keeping these facilities available for at least eight hours following total loss of *supply* at the *connection point* for the relevant *Generation Unit*.~~

~~(b) A *User* shall provide communications paths (with appropriate redundancy) between the *RME* or *RCE* installed at any of its *Generation Units* to a communications interface at the relevant *power station* and in a location reasonably acceptable to the *Network Operator*.~~

~~(c) Communications systems between this communications interface and the relevant *control centre* shall be the responsibility of the *Network Operator* unless otherwise agreed.~~

~~(d) The *User* shall meet the cost of the communications systems, unless otherwise determined by the *Network Operator*.~~

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

~~(1) Primary Speech *Facility*~~

~~(i) Each *User* shall provide and maintain equipment by means of which routine and emergency control telephone calls may be established between the *User's* responsible Engineer/Operator and the *Power System Controller*.~~

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

~~(2) Back-up Speech *Facility*~~

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

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

~~3.1.15.4 *Governor system*~~

~~(a) All *Generation Units* shall have an automatic governing system capable of droop governing. These *governor systems* shall include facilities for both speed and *load* control.~~

~~(b) The droop setting of the governor shall be adjustable and capable of operating in the range 1% to 6% droop.~~

~~(c) The *Power System Controller* will determine the governor mode of a *Generation Unit* in the system.~~

~~(d) Unless otherwise agreed between the *Network Operator* and the relevant *User* and stated in the *Access Agreement* between them, *Generation Units* shall normally operate in 'droop' mode.~~

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

~~(f) The *User* shall notify the *Power System Controller* prior to a *Generation Unit* being operated in a mode where the *Generation Unit* will be unable to respond as specified in the *Access Agreement*.~~

~~(g) The steady state deadband of a *Generation Unit* (sum of increase and decrease in *power system frequency* before a measurable *change* in the *Generation Unit's active power* output occurs) shall be less than 0.05 Hz.~~

~~(h) For a *load* increase of 20% of the *Generation Unit's nameplate rating*, the *Generation Unit* shall re-enter the steady state deadband within 3 seconds of the *load change*, provided that the *load* on the *Generation Unit* after the *load* increase does not exceed the *Generation Unit's nameplate rating*.~~

~~(i) The *governor system* of a *Generation Unit* shall be adjusted for stable performance under all operating conditions.~~

~~(j) The structure and parameter settings of all components of the governor control equipment, including the speed/*load controller*, actuators (for example hydraulic valve positioning systems), valve flow characteristics, limiters, valve operating sequences and steam tables for steam turbine (as appropriate) shall be provided to the *Network Operator* in sufficient detail to enable the dynamics of these components to be characterised for short and long term simulation studies. This shall include a control block diagram and all model parameters in suitable form to perform dynamic simulations and compatible with the *power system* analysis software used by the *Network Operator* (currently PSS/E from Siemens PTI). The proposed settings for the *governor system* for all expected modes of governor operation shall also be provided.~~

~~(k) These parameters shall not be varied without prior approval of the *Network Operator*.~~

~~The overriding objective of a *Generation Unit's* voltage control system is to maintain the specified voltage range at the *connection point*.~~

~~Each Generator must therefore provide sufficient *reactive power* injection into, or absorption from, the *transmission system* or *distribution system* to meet the *reactive power* requirements of its loads, plus all *reactive power* losses required to deliver its real power output at *system* voltages within the ranges specified in the relevant *Access Agreement* for normal operation and contingency conditions.~~

~~3.1.15.5 *Excitation control system*~~

~~The *excitation control system* of a *synchronous Generation Unit* shall be capable of:~~

~~(a) limiting *Generation Unit* operation at all *load* levels to within *Generation Unit* capabilities for continuous operation;~~

~~(b) controlling the *Generation Unit* output to maintain the short-*time* average *Generation Unit* output *voltage* at highest rated level (which shall be at least 5% above the nominal output *voltage* and is usually 10% above the nominal output *voltage*);~~

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

~~(d) in the case of a rotating synchronous generator, the five second ceiling excitation *voltage* shall be at least twice the excitation *voltage* required to achieve maximum continuous rating at nominal *voltage*; and~~

~~(e) providing reactive current compensation settable for boost or droop unless otherwise agreed by the *Network Operator*.~~

~~3.1.15.6 *Excitation control system* performance~~

~~(a) New *synchronous Generation Units* shall be fitted with fast acting *excitation control systems* utilising modern technology. AC exciter, rotating rectifier or *static excitation systems* shall be provided for any new *Generation Units* with a rating greater than 10 MW or for new smaller *Generation Units* within a *power station* totalling in excess of 10 MW. *Excitation control systems* shall provide *voltage* regulation to within 0.5% of the selected set point value.~~

~~(b) New non-synchronous *Generation Units* must be fitted with fast acting voltage and / or reactive power control systems, which must utilise modern technology and be approved by the *Network Operator*. Control systems must provide regulation to within 0.5% of the selected set point value.~~

~~(c) Unless agreed by the *Network Operator*, new *synchronous Generation Units* shall incorporate *power system stabiliser* circuits that modulate *Generation Unit* field *voltage* in response to *changes* in power output and/or shaft speed and/or any other equivalent input signal approved by the *Network Operator*. The stabilising circuits shall be responsive and adjustable over a *frequency* range that shall include frequencies from 0.1 Hz to 2.5 Hz.~~

~~(d) The *Network Operator* may require *power system* stabiliser circuits on *synchronous Generation Units* with ratings less than or equal to 10 MW or smaller *synchronous Generation Units* within a *power station* with a total *active power* output capability less than or equal to 10 MW (if *power system* simulations indicate a need for such a requirement). Before commissioning of any *power system* stabiliser, the *Generator* must propose preliminary settings for the power system stabiliser, which must be approved by the *Network Operator*.~~

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

~~(f) Before commissioning of any *power system stabiliser*, its preliminary settings shall be agreed by the *Network Operator*. The *User* shall propose these~~

~~preliminary settings that should be derived from system simulation studies and the study results reviewed by the *Network Operator*.~~

~~(g) The performance characteristics set out in Table 7 are required for AC exciter, rotating rectifier and *static excitation systems*.~~

~~Table 7 – *Synchronous Generator* excitation system performance requirements~~

Figure~~**Performance Item**~~	~~**Units**~~	~~**Static Excitation**~~	~~**A.C. Exciter or Rotating Rectifier**~~	~~**Notes**~~
~~***Sensitivity*:**~~ ~~A sustained 0.5% error between the *voltage* reference and the sensed *voltage* will produce an excitation *change* of not less than 1.0 per unit.~~	~~Open loop gain (ratio)~~	~~200 minimum~~	~~200 minimum~~	~~1~~
~~**Field *voltage* rise *time*:**~~ ~~*Time* for field *voltage* to rise from rated *voltage* to excitation ceiling *voltage* following the application of a short duration impulse to the *voltage* reference.~~	~~second~~	~~0.05 maximum~~	~~0.5 maximum~~	~~2~~
~~Settling *time* with the *Generator synchronised* following a disturbance equivalent to a 5% step *change* in the sensed *Generator* terminal *voltage*.~~	~~second~~	~~2.5 maximum~~	~~5 maximum~~	~~3~~
~~Settling *time* with the *Generator unsynchronised* following a disturbance equivalent to a 5% step *change* in the sensed *Generator* terminal *voltage*. Shall be met at all operating points within the *Generator* capability.~~	~~second~~	~~1.5 maximum~~	~~2.5 maximum~~	~~3~~
~~Settling *time* following any disturbance that causes an excitation limiter to operate.~~	~~second~~	~~5 maximum~~	~~5 maximum~~	~~3~~

~~**Notes:**~~

1. ~~One per unit is that field *voltage* required to produce nominal *voltage* on the air gap line of the *Generator* open circuit characteristic (Refer IEEE Standard 115-1983 – Test Procedures for Synchronous Machines).~~
2. ~~Rated field *voltage* is that *voltage* required to give nominal *Generator* terminal *voltage* when the *Generator* is operating at its maximum continuous rating. Rise *time* is defined as the *time* taken for the field voltage to rise from 10% to 90% of the increment value.~~
3. ~~Settling time is defined as the time taken for the Generator terminal voltage to settle and stay within an error band of ±10% of its increment value.~~

~~(h) The performance characteristics required for the voltage or reactive power control systems of all non-synchronous *Generation Units* are specified in Table 8.~~

~~**Table 8 – *Non-synchronous Generator voltage or reactive power* control system performance requirements**~~

Figure~~Performance Item~~	~~Units~~	~~Limiting Value~~	~~Notes~~
~~***Sensitivity:***~~ ~~A sustained 0.5% error between the reference *voltage* and the sensed *voltage* must produce an output change of not less than 100% of the *reactive power generation* capability of the *Generation Unit,* measured at the point of control.~~	~~Open loop gain (ratio)~~	~~200 minimum~~	~~1~~
~~**Rise time:**~~ ~~Time for the controlled parameter (*voltage* or *reactive power* output) to rise from the initial value to 90% of the change between the initial value and the final value following the application of a 5% step change to the *control system* reference.~~	~~second~~	~~1.5 maximum~~	~~2~~
~~**Small disturbance settling time**~~ ~~Settling time of the controlled parameter with the *Generation Unit* connected to the *transmission or distribution network* following a step change in the *control system* reference that is not large enough to cause saturation of the controlled output parameter. Must be met at all operating points within the *Generation Unit's* capability.~~	~~second~~	~~2.5 maximum~~	~~3~~
~~**Large disturbance settling time**~~ ~~Settling time of the controlled parameter following a large disturbance, including a *transmission or distribution network* fault, which would cause the maximum value of the controlled output parameter to be just exceeded.~~	~~second~~	~~5 maximum~~	~~3~~
~~**Notes:**~~ ~~1. A control system with both proportional and integral actions must be capable of achieving a minimum equivalent gain of 200.~~ ~~2. The controlled parameter and the point where the parameter is to be measured must be agreed and included in the relevant *Access Agreement*.~~ ~~3. Settling time is defined as the time taken for the controlled parameter to settle and stay within an error band of ±10% of its increment value.~~			

~~(i) The *Network Operator* shall approve the structure and parameter settings of all components of the *excitation control system*, including the *voltage* regulator, *power system stabiliser*, power amplifiers and all excitation limiters.~~

~~(j) The structure and settings of the *excitation control system* shall not be *changed*, corrected or adjusted in any manner without prior written~~

~~notification to the *Network Operator*. The *Network Operator* may require *Generation Unit* tests to demonstrate compliance with the requirements of Table 7 or Table 8. The *Network Operator* may witness such tests.~~

~~(k) Settings may require alteration from *time* to *time* as advised by the *Network Operator*. The cost of altering the settings and verifying subsequent performance shall be borne by the *User*, provided alterations are not made more than once in each 18 *months* for each *Generation Unit*. If more frequent *changes* are requested the person making that request shall pay all costs on that occasion.~~

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

~~3.1.16 *Power station* auxiliary *transformers*~~

~~In cases where a *power station* takes its auxiliary supplies through a *transformer* via a separate *connection point*, the *User* shall comply with the conditions for *connection* of *loads* (clause 3.6) in respect of that *connection point*.~~

~~3.1.17 *Synchronising*~~

~~(a) The *User* shall provide and install manual or automatic *synchronising* at the *Generator* circuit breakers.~~

~~(b) Check *synchronising* shall be provided on all *Generator* circuit breakers and any other circuit breakers, unless interlocked (as outlined in clause 3.3.1.1), that are capable of *connecting* the *User's Generation Facilities* to the *network*.~~

~~(c) Prior to the initial *synchronisation* of the *Generation Unit*(s) to the *network*, the *User* and the *Power System Controller* shall agree on the operational procedures necessary for *synchronisation*.~~

~~3.1.18 Secure electricity supplies~~

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

~~3.2~~3.4 Requirements for *connection* of *Small Generators*

~~3.2.1~~3.4.1 Scope

(a) This clause 3.4.1 addresses the requirements for the *connection* of *Small Generation Units* and groups of *Small Generation Units*.

(b) This clause 3.4.1 does not apply to the *connection* of *Small Inverter Energy Systems*, in respect of which clause 3.5 applies.

~~3.2.2~~3.4.2 Objectives

(a) The issues addressed by this clause 3.4.2 are:

(1) the possibility that *Small Generation Unit*s embedded in *network*s may affect the *quality of supply* to other *Users*, cause reverse *power transfer*, use up *network* capacity, create a *network* switching hazard and increase risks for operational personnel;

(2) the possibility that a *Small Generation Unit connect*ed to a *network* could become islanded on to a de-*energise*d part of the *network* resulting in safety and *quality of supply* concerns; and

(3) a simplified *connection* process for *Small Generator*s.

~~3.2.3~~3.4.3 Categorisation of facilities

(a) This clause 3.4.3 covers *Small Generation Unit*s of all types, whether using renewable or non-renewable *energy* sources.

(b) Unless otherwise specified, technical requirements for *Small Generation Unit*s will apply at the *connection point*, rather than at the *Generator* machine terminals, except that the *reactive power* requirements for *synchronous Small Generation Unit*s will apply at the *Generator* machine terminals.

(c) *Connection point*s for small *power stations* are characterised as:

(1) high *voltage connect*ed: 3 phase, 11 kV or 22 kV; or

(2) *low voltage connect*ed: 1, 2 or 3 phase plus neutral, 230 V or 400 V.

(3) Where a *Small Generation Unit* is the only *facility connect*ed to a *low voltage network* the *Generator* may choose to have the *power station* assessed for compliance as if the *power station* was high *voltage connect*ed. Prior to another *User* subsequently *connect*ing to the same *low voltage network* the *Network Operator* shall reassess the *power station* for compliance with the requirements for *low voltage connect*ed *power stations* and the *Small Generator* shall rectify any noncompliance identified in the reassessment.

(d) The mode of operation of a *Small Generation Unit* in a small *power station* is characterised as being in:

(1) continuous parallel operation with the *network*, and either exporting electricity to the *network* or not exporting electricity to it;

(2) occasional parallel operation with the *network*, and either exporting electricity to the *network* or not exporting electricity to it, including ~~*Generation Units*~~*generating units* participating in peak lopping and system *peak load* management for up to 200 hours per year;

(3) short term test parallel operation with the *network*, and either exporting electricity to the *network* or not exporting electricity to it, and having a maximum duration of parallel operation 2 hours per event and 24 hours per year; or

(4) bumpless (make before break) transfer operation, being:

(i) operation in rapid transfer mode where, when *load* is transferred between the *Generation Unit* and the *network* or vice versa, the *Generation Unit* is *synchronise*d for a maximum of one second per event; or

(ii) operation in gradual transfer mode where, when *load* is transferred between the *Generation Unit* and the *network* or vice versa, the *Generation Unit* is *synchronise*d for a maximum of 60 seconds per event.

~~3.2.4~~3.4.4 Information to be provided by a *Small Generator*

(a) A *Small Generator* shall provide all information in relation to the design, construction, operation and configuration of that small *power station* as is required by the *Network Operator* to ensure that the operation and performance standards of the *network*, or other *Users*, are not adversely affected by the operation of the *power station*.

(b) Details of the kinds of information that may be required for *Small Generator*s are included in clause 11.

~~3.2.5~~3.4.5 Safety and *reliability*

The requirements imposed on a *Small Generator* by this clause 3.4.5 are intended to provide minimum safety and *reliability* standards for the *network* and other *Users*.

(a) A *Small Generator* shall design its facilities in accordance with applicable standards and regulations, *good electricity industry practice* and the manufacturers' recommendations.

(b) The safety and *reliability* of the *network* and the equipment of other *Users* are paramount and *connection* applications shall be evaluated accordingly.

(c) A *Small Generator* shall not *connect* or re*connect* to the *network* if the safety and *reliability* of the *network* or *Users* would be placed at risk.

(d) Where it is apparent that the operation of equipment installed in accordance with the requirements of this clause may have an adverse impact on the operation, safety or performance of the ~~*network*,~~*network* or on the *quality of supply* to other *Users*, the *Network Operator* shall consult with the *Users* to reach an agreement on an acceptable solution.

(e) Pursuant to clause 3.4.5(d), the *Network Operator* may require the *Small Generator* to test or modify its relevant equipment.

(f) Unless otherwise agreed in the relevant ~~*Access Agreement*~~*connection agreement*, the *Network Operator* may require a *Small Generator* not to operate equipment in abnormal *network* operating conditions.

(g) Equipment directly *connect*ed to the *connection point* of a small *power station* shall be rated for the *maximum fault current* at the *connection point* specified in clause 2.8.

(h) A *Small Generator* shall ensure that the *maximum fault current* contribution from a *Generation Unit* or small *power station* is not of a magnitude that will allow the total fault current at the *connection point* to exceed the levels specified in clause 2.8 for all normal operating conditions.

~~3.2.6~~3.4.6*Small Generation Unit* characteristics

(a) To assist in controlling *network* fault levels, *Small Generator*s shall ensure that ~~*Generation Units*~~*generating units* comply with the *Network Operator's* requirements relating to *minimum fault current* and *maximum fault current* contribution through a *connection point*.

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

~~3.2.7~~3.4.7Connection and operation

~~3.2.7.1~~3.4.7.1 Main switch

(a) Each *facility* at which a *Small Generation Unit* in a small *power station* is *connect*ed to the *network* shall contain one main switch provided by the *User* for each *connection point* and one main switch for each *Generation Unit*, where a *Small Generation Unit* shares a *connection point* with other *Small Generation Unit*s or *load*s. For larger installations, additional *connection point*s and main switches or a dedicated feeder may be required.

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

(c) At each relevant *connection point* there shall be a means of visible and lockable isolation and test points accessible to the *Network Operator's* operational personnel. This may be a withdrawable switch, a switch with visible contacts, a set of removable links or other approved means. It shall be possible for the *Network Operator's* operational personnel to fit safety locks on the isolation point. *Low voltage Small Generation Unit*s with moulded case circuit breakers and fault limiting fuses with removable links are acceptable for isolation points in accordance with this sub clause.

~~3.2.7.2~~3.4.7.2 *Synchronising*

(a) For a synchronous *Small Generation Unit* in a small *power station*, a *Small Generator* shall provide automatic *synchronising* equipment at each *Small Generation Unit* circuit breaker.

(b) Check *synchronising* shall be provided on all *Small Generation Unit* circuit breakers and any other switching devices that are capable of *connect*ing the *User's* generating equipment to the *network* unless otherwise interlocked to the satisfaction of the *Network Operator*.

(c) Prior to the initial *synchronisation* of the *Generation Unit*(s) to the *network*, the *Small Generator* and the *Network Operator* shall agree on written operational procedures for *synchronisation*.

~~3.2.7.3~~3.4.7.3 Safe shutdown without external *supply*

A *Small Generation Unit* shall be capable of being safely shut down without electricity *supply* being available from the *network*.

~~3.2.8~~3.4.8 Power quality and *voltage change*

(a) A *Small Generator* shall ensure that the *network* performance standards of clause 2 are met when a small *power station* is *connect*ed by it to the *network*.

(b) The step *voltage change* at the *connection point* for *connection* and *disconnection* shall comply with the requirements of clause 2.3.3. These requirements may be achieved by *synchronising* individual ~~*Generation Units*~~*generating units* sequentially. On *low voltage* feeders, *voltage change*s up to 5% may be allowed in some circumstances with the approval of the *Network Operator*.

(c) The steady state *voltage* rise at the *connection point* resulting from export of power to the *network* shall not exceed 2% and shall not cause the *voltage* limits specified in clause 2.3.1 to be exceeded.

(d) When operating *unsynchronise*d, a synchronous *Small Generation Unit* in a small *power station* shall generate a constant *voltage* level with balanced phase *voltage*s and harmonic *voltage* distortion equal to or less than permitted in accordance with either *Australian Standard* AS 1359 (1997) "General Requirements for Rotating Electrical Machines" or a recognised relevant international standard, as agreed between the *Network Operator* and the *User*.

~~3.2.9~~3.4.9 Remote control, monitoring and communications

(a) For *Small Generation Unit*s exporting 1 MW or more to the *network* the *Generator* shall provide for:

(1) tripping of the *Small Generation Unit* remotely from the *Network Operator's control centre*;

(2) a close-enable interlock operated from the *Small Network Operator's control centre*; and

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

(b) For *Small Generation Units* exporting less than 1 MW monitoring may not be required.

(c) Where concerns for safety and *reliability* arise that are not adequately addressed by automatic *protection systems* and interlocks, the *Network Operator* may require the *Small Generator* to provide remote monitoring and remote control of some functions in accordance with this clause 3.4.9.

(d) A *Small Generator* shall provide a continuous communication link with the *Network Operator's control centre* for monitoring and control for *Small Generation Units* exporting 1 MW and above to the *network*. For *Small Generation Units* exporting below 1 MW, non-continuous monitoring and control may be required eg. a bi-*directional* dial up arrangement.

(e) A *Small Generator* shall have available at all times a telephone link or other communication channel to enable voice communications between a small *power station* and the *Network Operator*'s *control centre*.

(f) For *Small Generation Units* exporting above 1 MW, a dedicated telephone link or other dedicated communication channel may be required.

~~3.2.10~~3.4.10 ***Protection***

~~3.2.10.1~~3.4.10.1 General

(a) A *Small Generator* shall provide, as a minimum, the *protection* functions specified in this clause in accordance with the aggregate rated capacity of *Small Generation Units* in a small *power station* at the *connection point*.

(b) A *Small Generator*'s proposed *protection system* and settings shall be approved by the *Network Operator*, who shall assess their likely effect on the *network* and may specify modified or additional requirements to ensure that:

(1) the *network* performance standards specified in clause 2 are met;

(2) the *power transfer capability* of the *network* is not reduced; and

(3) the *quality of supply* to other *Users* is maintained. Information that may be required by the *Network Operator* prior to giving approval is specified in clause 11.

(c) A *Small Generator*'s *protection system* shall clear internal *plant* faults and coordinate with the *Network Operator's protection system*.

(d) The design of a *Small Generator*'s *protection system* shall ensure that failure of any *protection* device cannot result in the *network* being placed in an unsafe operating mode or lead to a disturbance or safety risk to the *Network Operator* or to other *Users*. This may be achieved by providing back-up *protection schemes* or designing the *protection system* to be fail-safe, eg. to trip on failure.

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

(f) All *Small Generators* shall provide under and over *voltage*, under and over *frequency* and overcurrent *protection scheme*s in accordance with the equipment rating.

(g) All *Small Generators* shall provide earth fault *protection* for earth faults on the *network*. All small *power station*s *connect*ed at high *voltage* shall have a sensitive earth fault *protection scheme*.

(h) The earth fault *protection scheme* may be:

(1) earth fault; or

(2) neutral *voltage* displacement

depending on the *connection* type).

(i) No *Small Generator* may *supply* a de-*energise*d *network* and all small *power station*s shall provide *protection* against abnormal *network* conditions, as specified in clause 3.2.3, on one or more phases. This *protection* against loss of external *supply* may be:

(1) loss of mains;

(2) *rate of change* of *frequency* (ROCOF);

(3) vector surge;

(4) reverse power; or

(5) *direction*al over current.

(j) All *Small Generators* that have an export limit shall have reverse power or *direction*al current limits set appropriate to the export limit.

(k) All *Small Generators* shall have loss of AC and DC auxiliary *supply protection*, which shall immediately trip all switches that depend on that *supply* for operation of their *protection*.

(l) Where *synchronisation* is *time* limited, the *Small Generator* shall be *disconnect*ed by an independent timer.

(m) *Small Generation Unit*s that are only operated in parallel with the *network* during rapid bumpless transfer shall be protected by an independent *time*r that will *disconnect* the *Generation Unit* from the *network* if the bumpless transfer successfully completed. Automatic transfer switches shall comply with Australian Standard AS 60947.6.2 (2004). For the avoidance of doubt *Small Generation Unit*s covered by sub-clause 3.4.10.1(m) need not comply with sub sub-clauses (f) to (l) of clause 3.4.10.1. This exemption recognises that the rapid bumpless transfer will be completed or the *Generation Unit* will be *disconnect*ed by the *disconnection* timer before other *protection scheme*s operate. *Protection* of the *Small Generation Unit* when it is not operating in parallel with the *network* is at the discretion of the *Small Generator*.

~~3.2.10.2~~3.4.10.2 Pole slipping

Where it is determined that the disturbance resulting from loss of synchronism is likely to exceed that permitted in clause 2.6, the *Small Generator* shall install a pole slipping *protection scheme*.

~~3.2.10.3~~3.4.10.3 Islanding *protection* and intertripping

(a) For sustained parallel operation (which excludes rapid or gradual bumpless transfer), islanding *protection schemes* of two different functional types shall be provided to prevent a *Small Generation Unit* energising a part of the *network* that has become isolated from the remainder of the *transmission* or *network* under all operating modes. The *Small Generator* shall demonstrate that two different functional types of islanding *protection schemes* have been provided.

(b) *Small Generation Units* designed for gradual bumpless transfer shall be protected with at least one functional type of islanding *protection scheme*.

(c) Islanding *protection* shall operate within 2 seconds to ensure *disconnection* before the first *network* reclosing attempt (typically 5 seconds). Relay settings are to be agreed with the *Network Operator*. It should be assumed that the *Network Operator* will always attempt to auto-reclose to restore *supply* following transient faults.

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

~~3.2.10.4~~3.4.10.4 *Protection* of *Small Generator*'s equipment

(a) This clause 3.4.10.4 applies only to *protection* necessary to maintain *power system security*. A *Small Generator* shall design and specify any additional *protection* required to guard against risks within the *Small Generator*'s *facility*.

(b) Any failure of the *Small Generator*'s tripping supplies, *protection apparatus* or circuit breaker trip coils required under clause 3.4.10 shall be alarmed within the *Small Generator*'s *facility* and operating procedures put in place to ensure that prompt action is taken to remedy such failures. As an alternative to alarming, *Small Generation Unit* main switches may be tripped automatically.

~~3.2.11~~3.4.11 Commissioning and testing

The *Small Generator* shall comply with the testing and commissioning requirements for *Small Generation Units connected* to the *network* specified in clause 7.

~~3.2.12~~3.4.12 Technical matters to be coordinated

As an alternative to *network augmentation*, the *Network Operator* may require a *Generator* to provide additional *protection scheme*s to ensure that operating limits and agreed import and export limits are not exceeded.

~~3.3~~3.5 Requirements for *connection* of *Small Inverter Energy Systems*

The *Network Operator* is not able to enter an *energy* buyback agreement directly. A *User* wishing to enter into such an agreement shall apply to a participating retailer. It should also be noted that whereas this clause 3.5 covers *connection* issues for *Small Inverter Energy Systems* of up to 30 kVA, the maximum capacity that a retailer may be prepared to enter into an *energy* buyback agreement may be less than this amount.

~~3.3.1~~3.5.1 Scope

(a) Clause 3.5 addresses the particular requirements for the *connection* of *Small Inverter Energy Systems* to the *Network Operator's low voltage network*.

(b) For similarly rated non-Inverter *Energy* systems, the requirements of clause 3.4 for *Small Generator*s apply.

(c) The scope of clause 3.5 is limited to technical conditions of *connection*.

~~3.3.2~~3.5.2 Relevant standards

(a) The installation of primary *energy* systems shall comply with the relevant *Australian Standard*s and international standards.

(b) Inverter systems shall satisfy the requirements of *Australian Standard* AS 4777 *"*Grid connection of energy systems via inverters*"* as published and revised. The following parts of this standard apply:

(1) AS 4777.1 – 2005 Part 1 Installation requirements.

(2) AS 4777.2 – 2005 Part 2 Inverter requirements.

(3) AS 4777.3 – 2005 Part 3 Grid *protection* requirements.

(c) The term *'*Inverter *Energy* system*'* in these Rules has the same meaning as in *Australian Standard* AS 4777.

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

(e) Should it be necessary to *change* any parameter of the equipment as installed and contracted, approval shall be sought from the *Network Operator*. Subsequently, the *Network Operator* shall determine whether a revised application is required.

~~3.3.3~~3.5.3 *Metering* installation

The *User* shall make provision for import and export *metering* in accordance with the requirements of clause 10.4.

~~3.3.4~~3.5.4 Safety

(a) Installations shall comply with the relevant *Australian Standard*s and all statutory requirements including Australian Standards AS/NZS 3000, AS/NZS 5033 and *Power and Water's* Power Networks Service Rules and Power Networks Installation Rules.

(b) All electrical installation, commissioning and maintenance work wherever required shall be carried out by an electrical contractor licensed under the *Northern Territory Electrical Workers and Contractors Act*, as in force at ~~25 November 2011~~4 July 2016.

~~3.3.5~~3.5.5 Security of operational settings

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

~~3.3.6~~3.5.6 Circuit arrangements

~~3.3.6.1~~3.5.6.1 Schematic diagram

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

~~3.3.7~~3.5.7 *Protection*

(a) A *Small Inverter Energy System connect*ed to the *network* shall be approved by the *Network Operator* and meet the requirements of relevant standards in accordance with clause 3.5.2 and the following requirements below.

(b) The *User* shall provide the information required by the *Network Operator* prior to approval being given.

~~3.3.7.1~~3.5.7.1 Islanding *protection*

The islanding function shall be automatic and shall physically remove the *Small Inverter Energy System* from the *network*. The Islanding *protection* shall be capable of detecting loss of *supply* from the *network* and *disconnect* the *Small Inverter Energy System* from the *network* within 2 seconds.

~~3.3.7.2~~3.5.7.2 *Synchronising*

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

~~3.3.7.3~~3.5.7.3 Reconnection to *network*

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

~~3.3.7.4~~3.5.7.4 Overcurrent *protection*

Overcurrent *protection* shall be provided at the isolating switch of a *Small Inverter Energy System* in accordance with the equipment rating, unless otherwise agreed with the *Network Operator*.

~~3.3.7.5~~3.5.7.5 *Voltage* limits

(a) The Inverter *voltage* limits shall be set according to equipment capability and *Australian Standard* AS 4777.

(b) The *Small Inverter Energy System* shall remain *connected* for *voltage* variations within the limits of Figure 10~~Table 9~~ unless otherwise agreed with the *Network Operator*. The *network voltage* range is based on 5-minute averages of the RMS value.

Figure 10 - *Low voltage* limits for *Small Inverter Energy Systems*

Nominal *voltage*	Lower limit	Upper limit
230 V	226 V	254 V
400 V	390 V	440 V

(c) The *Network Operator* is not responsible for failure of the *Small Inverter Energy System* to remain *connected* for the full range of *voltage* on the *network* set out in Figure 10~~Table 9~~.

~~3.3.7.6~~3.5.7.6 *Frequency* limits

(a) The Inverter *frequency* limits shall be set according to the equipment capability and *Australian Standard* AS 4777.

(b) The *Small Inverter Energy System* shall remain *connected* for *frequency* variations between 47.5 Hz and 52 Hz unless otherwise agreed with *Network Operator*.

~~3.3.8~~3.5.8 Commissioning and testing

~~3.3.8.1~~3.5.8.1 Commissioning

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

(b) In commissioning equipment installed under clause 3.5.8, a *User* shall verify that:

(1) The approved schematic has been checked and accurately reflects the installed electrical system.

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

(3) Signage and labelling comply with that specified in *Power and Water*'s Service Rules.

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

(5) Operational settings are secure as specified.

(6) The islanding *protection* operates correctly and *disconnect*s the Inverter *Energy* system from the *network* within 2 seconds.

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

(c) Subsequent modifications to the inverter installation shall be submitted to the *Network Operator* for approval.

~~3.3.8.2~~3.5.8.2 Re-confirmation of correct operation

(a) The *Network Operator* may elect to inspect the proposed *Small Inverter Energy System* from *time* to *time* to ensure continued compliance with these requirements. In the event that the *Network Operator* considers that the installation poses a threat to safety, to *quality of supply* or to the integrity of the *network* it may *disconnect* the generating equipment.

(c) *Small Inverter Energy System protection system*s shall also be tested for correct functioning at regular intervals not exceeding 5 years. The *User* shall arrange for a suitably qualified person to conduct the tests. Results of tests shall be certified by a competent person and supplied to the *Network Operator*.

~~3.4~~3.6 Requirements for *connection* of *load*s

The following requirements apply to the *connection* of *load*s to *network*s.

(a) These requirements and particular provisions may be waived for smaller *Users* and *Users* that have no potential to affect other *Users*, at the discretion of the *Network Operator*.

(b) Nothing in this clause 3.6 waives the requirements for all installations to comply with the *Network Operator's* Service and Installation Rules, *Metering* Manual, Contractor's Bulletins, and any requirement included in a~~n~~ ~~*Access Agreement*~~*connection agreement*.

~~3.4.1~~3.6.1 *Connection point* for a *User*

*Connection point*s between a *User's facility* and a *network* will be defined in the ~~*Access Agreement*~~*connection agreement*.

~~3.4.2~~3.6.2 Information

Before any new or additional equipment is *connect*ed, the *User* may be required to submit information to the *Network Operator* in accordance with clause 11.

~~3.4.3~~3.6.3 Design standards

Changes to the *power system* may result in the requirements for *connect*ed equipment changing. For example, as additional *plant* is *connect*ed to the *power system* fault levels will increase and the *User's plant* may no longer be suitable for *connection* to the system.

(a) A *User's* installation shall comply with the relevant *Australian Standard*s as applicable at the *time*, *good electricity industry practice* and this *Code*, including, but not limited to, the *quality of supply* standards as specified in clause 2.4.

(b) All *plant* ratings shall co-ordinate with the equipment installed on the *Network Operator power system*.

(c) *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*.

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

(e) If, after installation of a *User's* facilities, it is found that the installation is adversely affecting:

(1) the security or *reliability* of the *power system*;

(2) the *quality of supply*; or

(3) the installation does not comply with the *Code* or the relevant ~~*Access Agreement*~~*connection agreement*;

the *User* shall be responsible for remedying the problem at the *User's* cost, and within a *time* frame reasonably required by the *Network Operator*.

~~3.4.4~~3.6.4 *Users' protection system*s that impact on *power system security*

(a) Where a *User connection* to the *network* may affect *power system security*, the *protection system*s of the *User's connection* shall comply with the requirements of clause 3.2.3.

(b) *Protection* of the *connection* equipment solely for the *User's* risks is at the *User's* discretion.

~~3.4.5~~3.6.5 Thermal limits

The thermal ratings of the *network* components shall comply with the specifications set out in clause 15.3 of the *Network Planning Criteria*.

~~3.4.6~~3.6.6 Fault limits

The calculated fault levels in the *network*s shall not exceed 95% of the equipment fault ratings set out in clause 15.4 of the *Network Planning Criteria*.

~~3.4.7~~3.6.7 *Power factor* requirements

> The *power factor* of a *load connection* affects the required capacity of the *network* to *supply* the *load* and the management of *voltage* conditions on the *network*.
>
> *Power factor* improvement may be achieved by installing additional *reactive plant* or reaching a commercial agreement with the *Network Operator* to install, operate and maintain equivalent *reactive plant* as part of *connection assets*.

(a) *Power factor* ranges to be met by *Users* for their *loads* are shown in the Figure 11~~Table 10~~.

Figure 11 - *Power factor* requirements (*Loads*)

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

(b) The *Network Operator* may permit a lower lagging or leading *power factor* where this will not reduce system security and/or *quality of supply*, or require a higher lagging or leading *power factor* to achieve required *power transfers*.

(c) If the *power factor* falls outside the range in the table over any critical loading period nominated by the *Network Operator*, the *User* shall, where required by the *Network Operator* in order to economically achieve required *power transfer* levels, take action to ensure that the *power factor* falls within range as soon as reasonably practical.

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

4 *Power system* operation support ~~*security*~~

This section 4 of the *Network Technical Code* establishes requirements relating to the operation of the electricity network (including the operation of the network in emergency situations). It applies to the *Network Operator*~~, the *Power System Controller*~~ and all *Network Users*.

~~The *Power System Controller* has responsibility for control of the day-to-day dispatch of generators and associated ancillary services and for maintaining power system security.~~

~~The following related operational matters are set out in the *System Control Technical Code*:~~

~~(a) operating protocols;~~

~~(b) arrangements for system security and dispatch;~~

~~(c) arrangements for disconnection; and~~

~~(d) any other matters necessary to the efficient operation, monitoring and control of the *power system*.~~

4.1 ~~Introduction~~[Deleted]

4.1.1 [Deleted] ~~Purpose and application of clause 4~~

~~(a)~~ [Deleted] ~~Clause 4 of the *Code* applies to, and defines obligations for all *Users*, including:~~

~~(1) the framework for achieving and maintaining a secure *power system*;~~

~~(2) the conditions under which the *Power System Controller* can issue *directions* to *Users* so as to maintain or re-establish a secure *power system*.~~

~~(b) By virtue of this clause 4, the *Power System Controller* has the responsibility to maintain *power system security* within the design and operating limits determined by the *Network Operator*.~~

4.2 ~~*Power system security* principles~~

[Deleted]~~This clause 4.2 sets out certain definitions and concepts that are relevant to *power system security*.~~

4.2.1 ~~*Power system operating state*~~

~~(a)~~ [Deleted] ~~The Power System Controller shall define the operating states of the power system in the *System Control Technical Code*:~~

~~(1) *satisfactory operating state*; and~~

~~(2) *secure operating state*.~~

~~(b) The definition of operating states in section 4.2.1(a) shall be in accordance with:~~

~~(1) operating frequency requirements set out in clause 2.2 of this *Code*;~~

~~(2) voltage requirements set out in clause 2.3 of this *Code*;~~

~~(3) current flows for lines and equipment within the ratings defined by the *Network Operator*;~~

~~(4) the *power system* stability requirements set out in clause 2.6; and~~

~~(5) the technical envelope of power system performance set out in clause 4.2.2.~~

4.2.2 ~~*Technical envelope*~~

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

~~(b) The *Network Operator* shall determine and revise the *technical envelope* (as may be necessary from *time* to *time*) by taking into account the prevailing *power system* and *plant* conditions as described in clause 4.2.2(c).~~

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

~~(1) the *Network Operator* forecast total *power system load*;~~

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

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

~~(4) *contingency capacity reserves* available to handle *credible contingency events* in accordance with clauses 2.6 and 2.7 of this *Code*;~~

~~(5) agreed *Generation load constraints*;~~

~~(6) *constraints* on the *network*, including short term limitations;~~

~~(7) *frequency* control requirements;~~

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

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

4.2.3 ~~General principles for maintaining *power system security*~~

~~[Deleted]~~ Responsibilities ~~**The power system security principles are as follows:**~~

~~(a) **To the extent practical, the Power System Controller shall operate the power system such that it is and will remain in a secure operating state.**~~

~~(b) **Following a credible contingency event or a non-credible contingency event, the power system may no longer be in a secure condition on the occurrence of a further contingency event. In that case, the Power System Controller shall take**~~

~~all reasonable actions to return the power system to its satisfactory operating state as soon as practical, in accordance with the System Control Technical Code.~~

~~(c) The Network Operator shall ensure the provision of adequate load shedding facilities initiated automatically by frequency or voltage conditions outside the normal operating frequency or voltage excursion band to restore the power system to a satisfactory operating state following a significant contingency event.~~

~~(d) The Power System Controller shall ensure adequate load shedding facilities are in service to restore the power system to a satisfactory operating state following a significant contingency event.~~

~~(e) A User shall be required, either under their Access Agreement or ancillary services agreement, 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.~~

~~(f) Users shall arrange sufficient black start-up provisions so as to allow the restoration and any necessary restarting of their Generation Units following a black system condition.~~

4.3 ~~Power system security obligations and responsibilities~~

4.3.1 [Deleted] ~~*Time* for undertaking action~~

~~An event which is required under this clause 4 of the *Code* to occur on or by a stipulated *day* shall occur on or by that *day* whether or not a *business day*.~~

4.3.2 *Network Operator*

(a) The *Network Operator* shall use its reasonable endeavours, including through the provision of appropriate information to *Users* to the extent permitted by law and under this *Code*, to ensure that:

(1) the power system;

(2) *network* equipment;

(3) *network* connections; and

(4) *User* equipment;

are specified, planned and developed in accordance with *power system security* principles and *good electricity industry practice*.

(b) Where an obligation is imposed on the *Network Operator* under this clause of the *Code* to arrange or control any act, matter or thing or to ensure that any other person undertakes or refrains from any act, that obligation is limited to a requirement for the *Network Operator* to use reasonable endeavours, including to give such *direction*s as are within its powers, to comply with that obligation.

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

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

(1) the *Network Operator* considers appropriate;

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

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

(e) In making information available in accordance with clause 4.3.2(d), the *Network Operator* shall use reasonable endeavours to ensure that such information is available to those *Users* who request the information on an equivalent basis.

(f) In the event that the *Network Operator*, in its reasonable opinion for reasons of safety to the public, the *Network Operator* personnel, *Users'* equipment or the *Network Operator* equipment~~ or for *power system security*~~, needs to interrupt *supply* to any *User*, the *Network Operator* will (*time* permitting) consult with the relevant *User* and as applicable, the *Power System Controller* prior to executing that interruption.

(g) The *Network Operator* in consultation with the *Power System Controller* shall arrange controls, monitoring and secure communication systems which are appropriate in the circumstances to facilitate a manually initiated, rotational *load shedding* and restoration process. ~~which may be necessary if there is, in the *Network Operator's* opinion, a prolonged major *power system* disruption.~~

4.3.3 [Deleted] ~~*Power System Controller*~~

~~The *Power System Controller* shall:~~

~~(a) Take reasonable steps to ensure that high *voltage* switching procedures and arrangements are utilised by *Users* to provide adequate *protection* of the *power system*.~~

~~(b) Assess potential infringement of the *technical envelope* or *power system operating procedures* that could affect the security of the *power system*.~~

~~(c) Operate the *power system* within the limits of the *technical envelope*.~~

~~(d) Operate all *plant* and equipment under its control or co-ordination within the appropriate operational or emergency limits that are either established by the *Network Operator* or advised by the respective *User*.~~

~~(e) Assess the impacts of any technical and operational *constraints* on the operation of the *power system*.~~

~~(f) Monitor the *dispatch* of *Generation Units* and *associated loads* to ensure they stay within both their allowable limits and the dynamic limits of the *technical envelope*.~~

~~(g) Determine any potential *constraint* on the operation of *Generation Units* and *loads* and to assess the effect of this *constraint* on the maintenance of *power system security*.~~

~~(h) Assess the availability and adequacy, including the dynamic response, of *contingency capacity reserves* and *reactive power reserves* in accordance with clause 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.~~

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

~~(j) Refer to other *Users*, as the *Power System Controller* deems appropriate, information of which the *Power System Controller* becomes aware in relation to significant risks to the *power system* where actions to achieve a resolution of those risks are outside the responsibility or control of the *Network Operator*.~~

~~(k) 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.~~

~~(l) 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) 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) Interrupt, subject to this clause 4.3.3, *Users' connections* as necessary during emergency situations to facilitate the re-establishment of the *satisfactory operating state* of the *power system*.~~

~~(o) Direct (as necessary) any *Users* to take action necessary to ensure, maintain or restore the *power system* to a *satisfactory operating state*.~~

~~(p) Co-ordinate and direct any rotation of widespread interruption of *demand* in the event of a major *supply* shortfall or disruption.~~

~~(q) Investigate and review all major *power system* operational incidents and to initiate action plans to manage any abnormal situations or significant deficiencies that could reasonably threaten *power system security*. All *Users* 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.~~

4.3.4 ~~*Network*~~ *Users*

(a) All *Users* shall co-operate with and assist the *Power System Controller* in the proper discharge of the *Power System Controller's power system security responsibilities*.

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

(c) All *Users* shall provide automatic *interruptible load* of the type described in clause 3.2.8. The level of this automatic *interruptible load* will be a minimum of 75% of their expected *demand*, or such other minimum *interruptible load* level as may be periodically determined by the *Network Operator* in accordance with clause 3.2.8.

(d) *Users* shall provide their *interruptible load* in manageable blocks spread over a number of steps within *under frequency* bands from 49.25 Hz down to 48.50 Hz as nominated by the *Power System Controller*.

4.4 [Deleted] ~~*Power system frequency* control~~

4.4.1 [Deleted] ~~*Power system frequency* control responsibilities~~

[Deleted] ~~The *Power System Controller* shall use its reasonable endeavours to:~~

~~(a) Control the *power system frequency* and associated *time* error in accordance with clause 2.2; and~~

~~(b) Ensure that the *power system frequency operating standards* set out in clause 2.2.1 of this *Code* are achieved.~~

4.4.2 ~~Operational *frequency* control requirements~~

[Deleted] ~~To assist in the effective monitoring of *power system frequency* by the *Power System Controller* the following provisions apply:~~

~~(a) The authority to control and direct the output of all *Generation Units* and *supply* to *loads* is given to the *Power System Controller* pursuant to clause 9.1.~~

~~(b) Each *User* shall ensure that all of its *Generation Units* have automatic and responsive speed *governor systems* and automatic *load* control schemes in accordance with the requirements of clause 3.3, so as to automatically adjust for *changes* in associated power *demand* or loss of *Generation* as it occurs through response to the resulting excursion in *power system frequency* and *associated load*.~~

~~(c) The *Power System Controller* shall use its reasonable endeavours to arrange to be available and specifically allocated to *regulating duty* such *Generation Facilities* as the *Power System Controller* considers appropriate which can be automatically controlled or directed by the *Power System Controller* to ensure that normal *load* variations do not result in *frequency* deviations outside the limitations specified in clause 2.2.1.~~

~~(d) The *Power System Controller* shall use its reasonable endeavours to arrange *ancillary services* and contractual arrangements associated with the availability, responsiveness and control of necessary *contingency capacity reserve* and the rapid un*loading* of *Generation* as may be reasonably necessary to cater for the impact on the *power system frequency* of potential *power system* disruptions ranging from the *critical single credible contingency event* to the most serious *contingency events*.~~

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

4.5 ~~Control of *network voltages*~~ Voltage control

4.5.1 *Network voltage control*

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

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

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

(d) The determination referred to in clause 4.5.1(b) shall include a review of the dynamic stability of the *voltage* of the *transmission network*.

(e) The limits determined in paragraph (c) shall be, subject to consultation, included in the System Secure Guidelines. ~~*Power System Controller* shall use its reasonable endeavours to maintain *voltage* conditions throughout the *network* in accordance with the technical requirements specified in clause 2.~~

(f) The *Network Operator* shall use its reasonable endeavours to arrange the provision of *reactive power* facilities and *power system voltage* stabilising facilities through:

(1) contractual arrangements for *ancillary services* with appropriate *Users*;

(2) obligations on the part of *Users*; or under their ~~*Access Agreement*~~*connection agreements*;

(3) provision of such facilities by the *Network Operator*.

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

(1) *synchronous Generator voltage controls* usually associated with *tap-changing transformers*; or *Generator* AVR set point control (rotor current adjustment);

(2) *synchronous condensers* (compensators);

(3) *static var compensators* (SVC);

(4) shunt capacitors;

(5) shunt *reactors*;

(6) series capacitors.

4.5.2 [Deleted] ~~Reactive power reserve requirements~~

~~(a)~~ [Deleted] ~~The *Power System Controller* shall use its reasonable endeavours to ensure that sufficient *reactive power reserve* is available at all times to maintain or restore the *power system* to a *satisfactory operating state* after the most critical *contingency event* as determined by previous analysis or by periodic contingency analysis by the *Power System Controller*.~~

~~(b) If *voltages* fall outside acceptable limits, and the means of *voltage control* set out in this clause 4.5.2 are exhausted, the *Power System Controller* shall take all reasonable actions, including to direct *changes* to *demand* (through~~

~~selective *load shedding* from the *power system*), additional *Generation* operation or reduction in the *transmission line* flows but only to the extent necessary to restore the *voltages* to within the relevant limits.~~

~~(c) A *User* shall comply with any *direction* made by the *Power System Controller* under this clause 4.5.2.~~

4.6 ~~*Power system operating procedures*~~ [New heading]

~~(a) The *Power System Controller* shall be responsible for developing and maintaining *power system operating procedures* including, but not limited to:~~

~~(1) basic electrical safety requirements;~~

~~(2) electrical safety instructions;~~

~~(3) general operating/field procedures; and~~

~~(4) station-specific procedures related to the operation of the power system in that station.~~

~~(b) The nature and effect of the *power system operating procedures* shall be set out in the *System Control Technical Code*.~~

4.6.1 *Network* operations

(a) [Deleted] ~~The *Power System Controller* shall conduct or direct operations on the *network* in accordance with the appropriate *power system operating procedures*, the *System Control Technical Code* and *good electricity industry practice*.~~

(b) *Users* shall operate their equipment interfacing with the *network* in accordance with the requirements of:

(1) this *Code;*

(2) any applicable ~~*Access Agreement*~~*connection agreement* or *ancillary services agreement;*

(3) the requirements of the *System Control Technical Code* and the *Network Operator's* Electrical Safety Manual; and

(4) the relevant *power system operating procedures*.

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

4.6.2 Switching of *reactive power* facilities

(a) [Deleted] ~~The *Power System Controller* may instruct a *User* to place reactive facilities belonging to or controlled by that *User* into or out of service for the purposes of maintaining *power system security* where prior arrangements concerning these matters have been made between the *Network Operator* and a *User*.~~

(b) Where a User and the *Network Operator* have made prior arrangements in relation to ~~have been made with~~ matters associated with power~~s~~ system security support, the ~~between the User and the *Network Operator*Without limitation to its obligations under such prior arrangements, a~~ *User* shall use reasonable endeavours to comply with ~~such an~~ relevant instructions given by the *Network Operator* or its authorised agent.

4.6.3 *[Deleted]* ~~*Generation* limits~~

~~Limits to the VAr *Generation* and absorption capability of *Generation Facilities* and reactive compensation *plant* such as *static var compensators* are not to be exceeded.~~

4.7 ~~*Power system security* operations~~*[Heading]*

4.7.1 [Deleted] ~~*Users'* advice~~

[Deleted] ~~A *User* shall promptly advise the *Power System Controller* at the *time* that the *User* becomes aware of any circumstance that could be expected to adversely affect the secure operation of the *power system* or any equipment owned or under the control of the *User*.~~

4.7.2 ~~*Protection or control system* abnormality~~

~~(a)~~ [Deleted] ~~If a *User* becomes aware that any relevant *protection or control system* is defective or unavailable for service, that *User* shall advise the *Power System Controller* in accordance with the requirements of the *System Control Technical Code*.~~

~~(b) If the *Power System Controller* considers the unavailability of the *protection system* in 4.7.2(a) to be a threat to *power system security*, the *Power System Controller* may direct that the equipment protected or operated by the relevant *protection or control system* be taken out of operation or operated as the *Power System Controller* directs.~~

~~(c) A *User* shall comply with a *direction* given by the *Power System Controller* under clause 4.7.2(b) at no cost to the *Power System Controller*.~~

4.7.3 ~~*Power System Controller* advice on *power system* emergency conditions~~

~~(a) The *Power System Controller* shall advise affected or potentially affected *Users* of all relevant details promptly after the *Power System Controller* becomes aware of any circumstance with respect to the *power system* which, in the reasonable opinion of the *Power System Controller* could be expected to materially adversely affect *supply* to or from *Users*.~~

~~(b) Without limitation, such circumstances may include:~~

~~(1) electricity capacity shortfall, being a condition where there are insufficient *network* or *supply* options available to enable the secure *supply* of the total *load* in a *region*;~~

~~(2) unexpected disruption of *power system security*, which may occur when:~~

~~(iv) an unanticipated major *power system contingency event* occurs; or~~

~~(v) significant environmental or similar conditions, including weather, storms or fires, are likely to, or are affecting the *power system*; or~~

~~(3) a *black system* condition.~~

4.7.4 [Deleted] ~~Managing a *power system contingency event*~~

~~(a) During the period when the *power system* is affected by a *contingency event* the *Power System Controller* shall carry out actions, in accordance with the guidelines set out in this *Code and the System Control Technical Code* to:~~

~~(1) identify the impact of the *contingency event* on *power system security* in terms of the capability of the *network*;~~

~~(2) identify and implement the actions required in each affected *region* to restore the *power system* to its *satisfactory operating state*.~~

~~(b) When *contingency events* lead to potential or actual electricity *supply* shortfall events, the *Power System Controller* shall follow the procedures outlined in clause 4.7.~~

4.7.5 Managing electricity *supply* shortfall events

(a) If, at any *time*, there are insufficient *supply* options available to securely *supply* total *load* in a *region*, as advised by the *Power System Controller*, the *Network Operator* shall direct a *User* to take such steps as are reasonable to immediately reduce its *load*.~~then, the *Power System Controller* may undertake all or any of the following:~~

(1) [Deleted] ~~recall of equipment *outages*;~~

(2) [Deleted] ~~disconnect one or more points of load connection as the Power System Controller considers necessary;~~

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

(b) A *User* shall use all reasonable endeavours to comply with a ~~notice~~ direction given under clause 4.7.5(a)~~)(3)~~.

(c) [Deleted] ~~If there is a major *supply* shortfall, the *Power System Controller* shall implement, to the extent practical, a sharing of *load shedding* across *interconnected regions* up to the *power transfer capability* of the *network*.~~

4.7.6 *Directions* by the ~~*Power System Controller*~~*Network Operator* ~~affecting *power system security*~~

(a) If the *Network Operator*, acting in response to a direction from the *Power System Controller*, -requires a *User* to do any act or thing which is considered reasonably necessary to ensure the security of the power system and compliance with this Code, a *User* shall use all reasonable endeavours to comply within a reasonable period of *time* with any such *directions* given to it by the *Network Operator*.

~~(a)~~(b) If a *User* does not comply with a *direction* within a reasonable period of time and as such a satisfactory operating state cannot be re-established, the *Network Operator* may disconnect the *User* without further recourse.~~Subject to the Power System Controller giving a User a reasonable period of time to take appropriate action:~~

(a) [Deleted] ~~The *Power System Controller* may give reasonable *directions* to any *User* in accordance with the provisions of the *System Control Technical Code* requiring the *User* to do any act or thing which the *Network Operator* considers reasonably necessary to ensure the security of the power system.~~

(b) [Deleted]~~A *User* shall use all reasonable endeavours to comply within a reasonable period of *time* with any such *directions* given to it by the *Network Operator*. If a *User* does not comply with a *direction* within a reasonable period of *time* and as such a *satisfactory operating state* cannot be re-established, the *Network Operator* may *disconnect* the *User* without further recourse.~~

4.7.7 *Disconnection* of ~~*Generation Units*~~*generating units* and/or *associated loads*

(a) Where, under this Code or the relevant ~~Access Agreement~~*connection agreement* the ~~*Power System Controller*~~ *Network Operator* has the authority or responsibility to disconnect either a Generation Unit or its associated load, then it may do so as described in clause 8.

~~(a) , then it may do so (either directly or through any agent) as described in clause 8.~~

(b) The relevant *User* and *associated load* shall provide all reasonable assistance to the *Network Operator* for the purpose of such *disconnection*.

4.7.8 Emergency *black start-up facilities*

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

4.7.9 [Deleted] ~~*Black system procedures*~~

~~(a) The *Power System Controller* shall develop *system black procedures* and set these procedures out in the *System Control Technical Code*.~~

~~(b) A *Generator User* shall develop the draft *black system* procedures for each of its *power stations* in accordance with the requirements of the *System Control Technical Code*.~~

~~(c) The *Power System Controller* may request amendments to a *User's* draft *black system* procedures or any proposed *changes* as the *Power System Controller*~~

~~reasonably considers necessary by notice in writing to the *User*, where use is to be made of the *network*.~~

~~(d) If the *Power System Controller* and a *User* are unable to agree on the amendments, the matter may be dealt with under the dispute resolution process described in clause 1.6.~~

4.7.10 *Black system* start-up

(a) [Deleted] ~~The *Power System Controller* shall advise a *User* if, in the *Power System Controller's* reasonable opinion, there is a *black system* condition which is affecting, or which may affect, that *User*.~~

(b) If a *User* is providing *black start-up facilities* under an *ancillary services agreement* with another *User*, then the *local black system procedures* for that *User* shall be consistent with this *Code* and their ~~*Access Agreement*~~*connection agreement*.

~~(c)~~ [Deleted] ~~The *Power System Controller* 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:~~

~~(d) actual *power system* requirements; or~~

~~(e)~~(c) ~~if the *User* is providing *black start-up facilities* to another *User* under an *ancillary services agreement*, the relevant *Access Agreement*.~~

~~(f)~~(d) [Deleted] ~~If the *Power System Controller* advises a *User* of a *black system* condition, and/or if the terms of the relevant *local black system procedures* require the *User* to take action, then the *User* shall comply with the agreed requirements of the *local black system procedures*.~~

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

4.7.11 [Deleted] ~~Review of operating incidents~~

~~(a)~~ [Deleted] ~~The *Power System Controller* shall conduct reviews of significant operating incidents or deviations from normal operating conditions in order to assess the adequacy of the provision and response of facilities or services, and the appropriateness of actions taken to restore or maintain *power system security*.~~

~~(b) For all cases where the *Power System Controller* has been responsible for the *disconnection* of a *User*, the *Power System Controller* shall provide a report of the review carried out to the *User* advising of the circumstances requiring that action.~~

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

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

~~(e) The *Power System Controller* shall provide to a *User* such information or reports relating to the performance of that *User's* equipment during *power system* incidents or operating condition deviations as that *User* reasonably requests and in relation to which the *Power System Controller* is required to conduct a review under this clause.~~

4.8 ~~*Power system security* support~~

4.8.1 [Deleted] ~~Remote control and monitoring devices~~

~~(a)~~ [Deleted] ~~All remote control, operational *metering* and monitoring devices and local circuits as described in clause 3, shall be installed and maintained by a *User* in accordance with the standards and protocols determined and advised by the *Power System Controller* (for use in the *Power System Controller's control centre*) for each:~~

~~(1) *Generation Unit* and *associated load connected* to the *network*;~~

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

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

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

~~(c) The controls and monitoring devices shall include the provision for indication of *active power* and *reactive power* output, and to signal the status and any associated alarm condition relevant to achieving adequate *protection* control and indication of the *network*, and the *User's plant* active and reactive output consumption.~~

4.8.2 ~~Operational control and indication communication facilities~~

~~In accordance with clauses 3.3.3.1, 3.3.3.2 and 3.3.3.3, as applicable, Each *User* shall provide and maintain the necessary primary and, where nominated by the *Network Operator*, back-up communications facilities for control, operational *metering* and indication from the relevant local sites to the appropriate interfacing termination as nominated by the *Network Operator*.~~

4.8.3 [Deleted] ~~*Power system* voice/data *operational communication* facilities~~

~~(a)~~ [Deleted] ~~The *Power System Controller* shall establish:~~

~~(1) procedures for written and oral communications on operational matters; and~~

~~(2) minimum telecommunications facilities to be provided by *Users*;~~

~~in the *System Control Technical Code*.~~

~~(b) *Each User* shall advise the *Power System Controller* of each nominated position for the purposes of giving or receiving *operational communications* in relation to each of its facilities in accordance with the requirements of the *System Control Technical Code*.~~

~~(c) Each *User* shall provide, for each nominated position, communication systems in accordance with the requirements of the *System Control Technical Code*.~~

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

~~(e) The *Power System Controller* shall advise all *Users* of nominated persons for the purposes of giving or receiving *operational communications* in accordance with the requirements of the *System Control Technical Code*.~~

4.8.4 ~~Records of *power system operational communication*~~

~~The *Power System Controller* shall establish the procedures for recording *power system operational communications* in the *System Control Technical Code*.~~

4.8.5 Agent communications

(a) A *User* may appoint an agent (called a *"User* Agent") to coordinate operations of one or more of its facilities on its behalf, but only with the prior written consent of the *Power System Controller*.

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

(c) The *Power System Controller* may only withhold its consent to the appointment of a *User* Agent under clause 4.8.5(a), if it reasonably believes that the relevant person is not suitably qualified or experienced to operate the relevant *facility* at the interface with a *network*.

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

(e) The *Power System Controller* and its *representative*s (including authorised agents) may:

(1) rely upon any communications given by a *User* Agent as being given by the relevant *User*; and

(2) rely upon any communications given to a *User* Agent as having been given to the relevant *User*.

(f) The *Power System Controller* is not required to consider whether any instruction has been given to a *User* Agent by the relevant *User* or the terms of those instructions.

4.9 *Nomenclature standards*

The *Network Operator* and *Users* are to comply with clause 6.14 of the SCTC in regard to nomenclature standards.

(a) [Deleted] ~~The Network Operator shall establish nomenclature standards for network equipment;~~

(b) [Deleted] ~~A *User* shall use the *nomenclature standards* for *network* equipment and apparatus as agreed with the *Network Operator* or failing agreement, as determined by the *Network Operator*.~~

(c) [Deleted] ~~A *User* shall use reasonable endeavours to ensure that its *representatives* comply with the *nomenclature standards* in any *operational communications* with the *Power System Controller*.~~

(d) [Deleted] ~~A *User* shall ensure that name plates on its equipment relevant to operations at any point within the *power system* conform to the requirements set out in the *nomenclature standards*.~~

(e) [Deleted] ~~A *User* shall use reasonable endeavours to ensure that nameplates on its equipment relevant to operations within the *power system* are maintained to ensure easy and accurate identification of equipment.~~

(f) [Deleted] ~~A *User* shall ensure that technical drawings and documentation provided to the *Network Operator* comply with the *nomenclature standards*.~~

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

(h) [Deleted] ~~All nomenclature shall be unique and unambiguous.~~

5 Testing of *plant* and equipment

> The testing of *plant* and equipment is required before *connection* to the *network* and periodically thereafter to ensure that the *network* and *connection*s can continue to operate within the parameters of the *network* performance standards set out in clause 2 and that equipment meets the requirements to be *connect*ed to the *network* set out in clause 3.

5.1 Obligations to test *plant* or equipment

5.1.1 *Network Operator* obligations

(a) The *Network Operator* shall arrange, co-ordinate and supervise the conduct of such appropriate tests as may be necessary to ensure that:

(1) the equipment at new *connection*s to the *network* meets the requirements set out in clause 3.

(2) the *protection* of the *network* is adequate to protect against damage to *power system plant* and equipment. Such tests shall be performed according to the requirements of clause 5.2.

(3) the *power system* capability and performance is adequate to meet forecast operating conditions and power flows, as set out in clause 5.5.

(4) adequate *reactive power* devices are provided and available to control and maintain *power system voltage*s under both *satisfactory operating state* and *contingency event* conditions;

(5) adequate devices are installed and available to maintain *power system* stability.

(6) *Users* continue to comply with the conditions set out in ~~*Access Agreement*~~*connection agreement*s and that all *Users' connection* equipment meets the requirements to set out in clause 3 and 5.4.

(7) the testing of *metering* installations is carried out in accordance with the NT NER. ~~clause 10.6~~

5.1.2 *Network Users'* obligations

(a) All *Network Users* shall cooperate to permit the testing of their *connection* equipment as required under clause 5.1.1.

(b) A *Generator* shall provide evidence that each *Generation Unit* complies with the technical requirements of clause 3.3 and the relevant ~~*Access Agreement*~~*connection agreement* as required by clause 5.4

5.2 Routine testing of *protection* equipment

(a) Subject to clause 3.2.3.10, a *User* shall cooperate with the *Network Operator* to test the operation of equipment forming part of a *protection scheme* relating to a *connection point* at which that *User* is *connect*ed to a *network* and the *User* shall conduct these tests:

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

(2) at intervals specified in the ~~*Access Agreement*~~*connection agreement* or in accordance with an asset management plan agreed between the *Network Operator* and the *User*.

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

(c) Each *User* shall pay the *Network Operator's* reasonable costs and shall bear its own costs of conducting tests under this clause 5.2.

5.3 Testing by *Users* of their own *plant* requiring *change*s 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*~~*connection agreement*, shall give notice in writing to the *Network Operator* of at least 15 *business day*s except in an emergency.

(b) The notice to be provided under clause 5.3(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 *Users*.

(c) The *Network Operator* shall review the proposed test to determine whether the test:

(1) could adversely affect the normal operation of the *power system*;

(2) could cause a threat to *power system security*;

(3) requires the *power system* to be operated in a particular way which differs from the way in which the *power system* is normally operated; or

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

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

(e) The *Network Operator* shall advise any other *User* 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 5.3 shall ensure that the person responsible for the coordination of a test promptly advises *Network Operator* when the test is complete.

(g) If the *Network Operator* approves a proposed test, the *Network Operator* shall use its reasonable endeavours to ensure that *power system* conditions reasonably required for that test are provided as close as is reasonably practical to the proposed start *time* of the test and continue for the proposed duration of the test.

(h) Within a reasonable period after any such test has been conducted, the *User* who has conducted a test under this clause 5.3 shall provide the *Network Operator* with a report in relation to that test including test results where appropriate.

5.4 Tests to demonstrate *Generator* compliance

(a) Each *User* shall provide evidence to the *Network Operator* that each of its ~~*Generation Units*~~*generating units* complies with the technical requirements of clause 3.3~~3.3.2~~ and the relevant ~~*Access Agreement*~~*connection agreement*.

(b) Each *User* shall provide facilities to carry out *power system* tests prior to commercial operation in order to verify acceptable performance of each *Generation Unit*, and provide information and data necessary for computer model validation. These test requirements are detailed in Attachment 5.

(c) Other tests, if reasonably necessary, may be specified by the *Network Operator,* and *Users* will be advised accordingly.

(d) Each *User* shall negotiate in good faith with the *Network Operator* to agree on a compliance monitoring program, including an agreed method, for each of its ~~*Generation Units*~~*generating units* to confirm ongoing compliance with the applicable technical requirements of clause 3.3 ~~3.3.2~~and the relevant ~~*Access Agreement*~~*connection agreement*.

(e) If a performance test or monitoring of in-service performance demonstrates that a *Generation Unit* is not complying with one or more technical requirements of clause 3.3 ~~3.3.2~~and the relevant ~~*Access Agreement*~~*connection agreement* then the *User* shall:

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

(2) promptly advise the *Network Operator* of the remedial steps it proposes to take and the *time*table for such remedial work; and

(3) diligently undertake such remedial work and report at *month*ly intervals to the *Network Operator* on progress in implementing the remedial action; and

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

(f) From the *Code commencement date* or from the date of access, whichever is the later, Each *User* shall maintain records and retain them for a minimum of 7 years (from the date of creation of each record) for each of its ~~*Generation Units*~~*generating units* and *power stations* setting out details of the results of all technical performance and monitoring conducted under this clause 5.4 and make these records available to *Network Operator* on request.

5.4.1 Tests of ~~*Generation Units*~~*generating units* requiring *change*s to agreed operation

(a) The *Network Operator* may, at intervals of not less than 12 *month*s per *Generation Unit*, require the testing by a *User* of any *Generation Unit* *connect*ed to the *network* of the *Network Operator* in order to determine analytic parameters for modelling purposes or to assess the performance of the relevant *Generation Unit*. The *Network Operator* is entitled to witness such tests and the *Network Operator* shall have reasonable grounds for requiring such tests.

(b) Adequate notice of not less than 15 *business day*s shall be given by the *Network Operator* to the *User* before the proposed date of a test under clause 5.4.1(a).

(c) The *Network Operator* shall use its reasonable endeavours to ensure that tests permitted under this clause 5.4.1 are to be conducted at a *time* which will minimise the departure from the *commitment* that is due to take place at that *time*.

(d) If not possible beforehand, a *User* shall conduct a test under this clause 5.4.1 at the next scheduled *outage* of the relevant *Generation Unit* and in any event within 9 *month*s of the request.

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

(f) Tests conducted under this clause 5.4.1 shall be conducted in accordance with test procedures agreed between the *Network Operator* and the relevant *User, who* shall not unreasonably withhold agreement to the test procedures proposed for this purpose by the *Network Operator*.

(g) The *Network Operator* shall provide to a *User* such details of the analytic parameters of the model derived from the tests referred to in this clause 5.4.1 for any of that *User's* ~~*Generation Units*~~*generating units* as may reasonably be requested by the *User*.

(h) Each *User* shall bear its own costs associated with tests conducted under this clause 5.4.1 and no compensation is to be payable for financial losses incurred as a result of these tests or associated activities.

5.5 *Power system* tests

(a) Tests conducted for the purpose of either verifying the magnitude of the *power transfer capability* of *network*s or investigating *power system* performance shall be coordinated and approved by the *Network Operator*. The *Network Operator* or a *User* requesting such tests shall have reasonable grounds for requiring such tests.

(b) The tests described in clause 5.5(a) may be conducted whenever:

(1) a new *Generation Unit* or *facility* of a Customer, *User* or a *network* development is commissioned that is calculated or anticipated to substantially alter *power transfer capability* through the *network*;

(2) setting *change*s are made to any *governor system* and *excitation control system*, including *power system stabiliser*s; or

(3) a test is required to verify the performance of the *power system* or to validate computer models.

(c) The *Network Operator* shall notify all *Users* who could reasonably be expected to be affected by the proposed test at least 15 *business day*s before any test under this clause 5.5 may proceed and to consider any reasonable requirements of those *Users* when approving the proposed test.

(d) Operational conditions for each test shall be arranged by the *Network Operator* and the test procedures shall be coordinated by an officer nominated by the *Network Operator* who has authority to stop the test or any part of it or vary the procedure within pre-approved guidelines if it considers any of these actions to be reasonably necessary.

(e) Each *User* shall cooperate with the *Network Operator* when required in planning, preparing for and conducting *network* tests to assess the technical performance of the *network*s 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 *Generation Unit*.

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

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

(h) Each *User* is to bear its own costs of conducting tests under this clause 5.5 and no compensation is to be payable for financial losses incurred as a result of these tests or associated activities.

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

5.6 Compliance with the *Network Technical Code*

5.6.1 Right of inspection and testing

(a) If the *Network Operator* has reasonable grounds to believe that equipment owned or operated by a *User* may not comply with this *Code* or the ~~*Access Agreement*~~*connection agreement*, the *Network Operator* may require testing of the relevant equipment by giving notice in writing to the *User*.

(b) If a notice is given under clause 5.6.1(a) the relevant test is to be conducted at a *time* agreed by the *Network Operator*.

(c) The *User* who receives a notice under clause 5.6.1(a) shall co-operate in relation to conducting tests requested under clause 5.6.1(a).

(d) The cost of tests requested under clause 5.6.1(a) shall be borne by the *Network Operator,* unless the equipment is determined by the tests not to comply with the relevant ~~*Access Agreement*~~*connection agreement*, and/or this *Code* in which case all reasonable costs of such tests shall be borne by the owner of that equipment.

(e) Tests conducted in respect of a *connection point* under this clause 5.6.1 shall be conducted using test procedures agreed between the relevant *User*, which agreement is not to be unreasonably withheld or delayed.

(f) Tests under this clause 5.6.1 shall be conducted only by persons with the relevant skills and experience.

(g) If the *Network Operator* requests a test under this clause 5.6.1, the *Network Operator* may appoint a *representative* to witness a test and the relevant *User* shall permit a *representative* appointed under this clause 5.6.1(g) to be present while the test is being conducted.

(h) Subject to clause 5.6.1(i), a *User* who conducts a test shall submit a report to the *Network Operator* within a reasonable period after the completion of the test and the report is to outline relevant details of the tests conducted, including but not limited to the results of those tests.

(i) If a performance test or monitoring of in-service performance demonstrates that equipment owned or operated by a *User* does not comply with this *Code* or the relevant ~~*Access Agreement*~~*connection agreement* then the *User* shall:

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

(2) promptly advise the *Network Operator* of the remedial steps it proposes to take and the *time*table for such remedial work; and

(3) diligently undertake such remedial work and report at *month*ly intervals to the *Network Operator* on progress in implementing the remedial action; and

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

(j) The *Network Operator* may attach test equipment or *monitoring equipment* to *plant* owned by a *User* or require a *User* to attach such test equipment or *monitoring equipment*, subject to the provisions of clause 5.7.1 regarding entry and inspection.

(k) In carrying out monitoring under clause 5.6.1(j), the *Network Operator* shall not cause the performance of the monitored *plant* to be *constrained* in any way.

5.6.2 *Generator* compliance with the *Code*

(a) If the *Network Operator* reasonably believes that a *Generator* is not complying with one or more technical requirements of clause 3.3 ~~3.3.2~~and the relevant ~~*Access Agreement*~~*connection agreement*, the *Network Operator* may instruct the *User* to conduct tests within 25 *business days* to demonstrate that the relevant *Generation Unit* complies with those technical requirements.

(b) If the tests provide evidence that the relevant ~~*Generation Unit*~~*generating unit* continues to comply with the technical requirement(s) *Network Operator* shall reimburse the *User* for the reasonable expenses incurred as a direct result of conducting the tests.

(c) If the *Network Operator*:

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

(2) does not have evidence demonstrating that a *generating unit* ~~*Generation Unit*~~ complies with the technical requirements set out in clause 3.3; or

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

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

(d) A *direction* under clause 5.6.2(c) shall be recorded by the *Network Operator*.

5.7 Inspection of *plant* and equipment

5.7.1 Right of entry and inspection

(a) The *Network Operator* or any of its *representatives* (including authorised agents) may, in accordance with this clause 5.7.1, inspect a *facility* of a *User* and the operation and maintenance of that *facility* in order to:

(1) assess compliance by the relevant *User* with its operational obligations under this *Code*, or an ~~*Access Agreement*~~*connection agreement*, or an *ancillary services agreement*; or

(2) investigate any possible past or potential threat to *power system security*; or

(3) conduct any periodic familiarisation or training associated with the operational requirements of the *facility*.

(b) If the *Network Operator* wishes to inspect the facilities of a *User* under clause 5.7.1(a), the *Network Operator* shall give that *User* at least 2 *business days'* notice in writing of its intention to carry out an inspection. In the case of an emergency condition affecting the *power system* which the *Network Operator* reasonably considers requires access to the *User's facility*, prior notice is not required, however, the *Network Operator* shall notify the *User* as soon as practical after deciding to enter the *User's facility* of the nature and extent of the *Network Operator's* activities at the *User's facility*.

(c) A notice given under clause 5.7.1 (b) shall include the following information:

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

(2) subject to clause 5.7.1(h), the *time* when the inspection will commence and the expected *time* when the inspection will conclude; and

(3) if associated with clause 5.7.1(a)(1) then the nature of the suspected non-compliance with the *Code* or ~~*Access Agreement*~~*connection agreement* or *ancillary services agreement*, or if associated with clauses 5.7.1(a)(2) or 5.7.1(a)(3) then the relevant reasons for the inspection.

(d) The *Network Operator* may not carry out an inspection under clause 5.7.1 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 4.7.11.

(e) At any *time* when the *representative* of the *Network Operator* is in a *Users' facility*, that *representative* shall:

(1) cause no damage to the *facility*;

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

(3) observe *"*permit to test*"* access to sites and clearance protocols of the operator of the *facility*, provided that these are not used by the *facility* solely to delay the granting of access to site and inspection;

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

(5) not ask any question other than as reasonably necessary for the purpose of such inspection or give any *direction*, instruction or advice to any person involved in the operation or maintenance of the *facility* other than the operator of the *facility* or unless approved by the operator of the *facility*.

(f) Any *representative* of the *Network Operator* conducting an inspection under this clause 5.7.1 shall be appropriately qualified and experienced to perform the relevant inspection. If so requested by the *User*, the *Network Operator* shall procure that a *representative* of *Network Operator* (other than an employee) gaining access under this *Code* or an ~~Access Agreement~~*connection 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 5.7.1 shall be borne by the *User* if the suspected non-compliance is later proved by tests.

(h) Any inspection under clause 5.7.1(a) shall not take longer than one *day* unless the *Network Operator* seeks approval from the *User* for an extension of *time* (such approval not to be unreasonably withheld or delayed).

(i) Any equipment or goods installed or left on land or in premises of a *User* after an inspection conducted under this clause 5.7.1 do not become the property of the relevant *User* (notwithstanding that they may be annexed or affixed to the relevant land or premises).

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

(1) shall not use any such equipment or goods for a purpose other than as contemplated in this *Code* without the prior written approval of the owner of the equipment or goods;

(2) shall allow the owner of any such equipment or goods to remove any such equipment or goods in whole or in part at a *time* agreed with the relevant *User* with such agreement not to be unreasonably withheld or delayed;

(3) shall not create or cause to be created any mortgage, charge or lien over any such equipment or goods; and

(4) shall reimburse the owner of any such equipment or goods for reasonable costs and expenses suffered or incurred by the owner due to loss or damage to any such equipment or goods caused by the *User*.

6 Control and *protection* settings

6.1 *Protection* of *power system* equipment

It is important to note that the requirements of this clause 6 are designed to adequately protect the *Network Operator's power system*. The requirements are not necessarily adequate to protect *Users' plant* and equipment.

6.1.1 Scope

(a) The requirements of clause 6.1 apply only to a *User's protection*, which is necessary to maintain *power system security*.

(b) *Users' protection schemes* shall be located on *Users'* equipment.

(c) *Protection* installed solely to cover risks associated with a *User's plant* and equipment is at the *User's* discretion.

(d) The extent of a *User's plant* and equipment that will need to conform to the requirements of clause 6.1 will vary from installation to installation.

(e) The *Network Operator* will assess each *User's* installation individually. *Users* will be advised accordingly.

6.1.2 *Power system* fault levels

(a) The *Network Operator* shall determine the fault levels at all *busbars* of the *Network Operator's network* as described in clause 6.1.2(b);

(b) The *Network Operator* shall ensure that there is information available about the *network* that will allow the determination of fault levels for normal operation of the *power system*. The *Network Operator* will make available on request the *credible contingency events* which the *Network Operator* considers may affect the configuration of the *power system* so that the *Network Operator* and *Users* can identify their *busbars* which could potentially be exposed to a fault level which exceeds the fault *current ratings* of the circuit breakers and other equipment associated with that *busbar*.

6.1.3 *Power system protection* co-ordination

The *Network Operator* shall use its reasonable endeavours to co-ordinate the *protection* settings for equipment *connected* to the *network*. *Users* with *protection systems* that impact *power system security* and *reliability* shall ensure their settings co-ordinate with the *Network Operator's protection*. Such *Users* may not adjust settings without the *Network Operator's* approval. Specific requirements are described in clauses 6.1.6.4 and 11.2.2.

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

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

(b) The *Power System Controller* shall use its reasonable endeavours not to exceed the *network* element ratings and not to require or recommend action that causes those ratings to be exceeded.

6.1.5 Availability of *protection*

(a) All elements of *protection schemes*, including *backup protection* and associated intertripping, shall be maintained so as to be available for service at all *times*.

(b) For maintenance or repair purposes, one *protection scheme* forming part of a *protection system* can be taken out of service for period of up to 24 hours every 6 *months*.

(c) At the discretion of the *Network* Controller, longer periods of unavailability may require the associated *primary plant* to be taken out of service in accordance with clause 6.1.6.

(d) Except in an emergency, a *User* shall notify the *Network Operator* at least 5 *business days* prior to taking a *protection scheme* out of service.

6.1.6 Partial *outage* of power *protection systems*

(a) Where there is an *outage* of one *protection* of a *network* element, the *Power System Controller* shall determine, the most appropriate action. Depending on the circumstances the determination may be:

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

(2) to take the *network* element out of service immediately;

(3) to install or direct installation of a temporary *protection*;

(4) to accept a degraded performance from the *protection*, with or without additional operational measures or temporary *protection* measures to minimise *power system* impact; or

(5) to operate the *network* element at a lower capacity.

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

(c) Any affected *User* shall accept a determination made by the *Network Operator* under this clause 6.1.6.

6.1.6.1 *Sensitivity* of *protection*

(a) All *protection schemes* shall have sufficient *sensitivity* to detect and correctly clear all *primary plant* faults within their intended normal operating zones, under both normal and *minimum system conditions*.

(b) *Protection schemes* shall discriminate with the *Network Operator's protection*.

(c) Under abnormal *plant* conditions, all primary system faults shall be detected and cleared by at least one *protection scheme* on the *User's* equipment. *Remote backup protection* or standby *protection* may be used for this purpose.

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

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

6.1.6.2 Clearance of *small zone fault*s

*Small zone fault*s shall be detected and cleared by *backup protection* as specified in clause 3.2.3.6.

6.1.6.3 Clearance of faults under circuit breaker fail conditions

Failure of a circuit breaker, due to either a mechanical or electrical fault, to clear a fault shall, when reasonably required by the *Network Operator*, be detected and the primary fault current shall be cleared by *backup protection* as specified in the clause 3.2.3.6.

6.1.6.4 Details of proposed *Users' protection* settings

Unless agreed otherwise, *Users* shall provide the *Network Operator* with full details of proposed *protection* settings and setting calculations on all *plant* that may impact on the *Network Operator's power system* a minimum of 65 *business day*s prior to *energisation* of the protected *primary plant*. Refer to clause 7.1.3.

6.1.6.5 Coordination of *protection* settings

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

(b) Generally, *Network Operator protection* which discriminates on the basis of *time* employs devices with standard inverse characteristics to BS EN 60255-6:1995 with a 3 second curve at 10 times current and *time* multiplier of 1.0. Note that this is the specification of the characteristic rather than the device setting. Distance relay Zone 2 *time* is generally set to 400 msec and Zone 3 *time* to 1000 msec.

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

6.2 *Power system* stability co-ordination

(a) The *Network Operator* shall use its reasonable endeavours to ensure that all necessary calculations associated with the stable operation of the *power system* as described in clause 2.6 and for the determination of settings of equipment used to maintain that stability are carried out and to co-ordinate these calculations and determinations.

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

7 Commissioning and testing procedures

7.1 Commissioning

7.1.1 Requirement to inspect and test equipment

(a) A *User* shall ensure that any of its new or replacement equipment is inspected and tested to demonstrate that it complies with relevant *Australian Standards*, relevant international standards, this *Code* and any relevant ~~*Access Agreement*~~*connection agreement* prior to or within an agreed *time* after being *connect*ed to a *network*, and the *Network Operator* is entitled to witness such inspections and tests.

(b) The *User* shall produce test certificates on request by the *Network Operator* showing that the equipment has passed the tests and complies with the standards set out in clause 7.1.1(a) before *connection* to the *power system*, or within an agreed *time* thereafter.

7.1.2 Co-ordination during commissioning

A *User* seeking to *connect* to a *network* shall cooperate with the *Network Operator* to develop procedures to ensure that the commissioning of the *connection* and *connect*ed *facility* is carried out in a manner that:

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

(b) Minimises the threat of damage to any other *Users'* equipment.

7.1.3 Control and *protection* settings for equipment

(a) Not less than 65 *business day*s prior to the proposed commencement of commissioning of any new or replacement equipment that could reasonably be expected to alter performance of the *power system*, the *User* shall submit to the *Network Operator* sufficient design information including proposed parameter settings to allow critical assessment including analytical modelling of the effect of the new or replacement equipment on the performance of the *power system*.

(b) The *Network Operator* shall:

(1) consult with other *Users* as appropriate; and

(2) within 20 *business day*s of receipt of the design information under clause 7.1.3(a), notify the *User* of any comments on the proposed parameter settings for the new or replacement equipment.

(c) If the *Network Operator's* comments include alternative parameter settings for the new or replacement equipment, then the *User* shall notify the *Network Operator* within 20 *business day*s that it either accepts or disagrees with the alternative parameter settings suggested by the *Network Operator*.

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

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

(f) The *User* shall pay the *Network Operator's* reasonable costs associated with the assessment of the parameter settings under this clause 7.1.3.

7.1.4 Commissioning program

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

(b) The *Network Operator* shall, within 20 *business day*s of receipt of such advice under clause 7.1.4(a), notify the *User* either that it:

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

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

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

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

(e) The *User* shall pay the *Network Operator's* reasonable costs associated with the assessment of the commissioning program under this clause 7.1.4.

7.1.5 Commissioning tests

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

(b) Prior to *connection* to the *Network Operator's power system*, the *User* shall have provided to the *Network Operator* a signed written statement to certify that the equipment to be *connect*ed has been installed in accordance with:

(1) this *Code*;

(2) the relevant ~~*Access Agreement*~~*connection agreement*;

(3) all relevant standards;

(4) all statutory requirements; and

(5) *good electricity industry practice*.

(c) The statement shall have been certified by a professional engineer, as approved by the *Network Operator*.

(d) The *Network Operator* shall, within a reasonable period of receiving advice of commissioning tests, notify the *User* whose new or replacement equipment is to be tested under this clause 7.1.5 whether or not it:

(1) wishes to witness the commissioning tests; and

(2) agrees with the proposed commissioning times.

(e) A *User* whose new or replacement equipment is tested under this clause 7.1.5 shall submit to the *Network Operator* the commissioning test results demonstrating that a new or replacement item of equipment complies with this *Code* or the relevant ~~*Access Agreement*~~*connection agreement* or both to the satisfaction of the *Network Operator*.

(f) 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*~~*connection agreement* then the *User* whose new or replacement equipment was tested under this clause 7.1.5 shall promptly meet with the *Network Operator* to agree on a process aimed at achievement of compliance of the relevant item with this *Code*.

(g) The *Network Operator* may direct that the commissioning and subsequent *connection* of the *User's* equipment should not proceed if the relevant equipment does not meet the technical requirements specified in clause 7.1.1.

(h) 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*.

(i) The *User* shall pay the *Network Operator's* reasonable costs associated with the witnessing of commissioning tests under this clause 7.1.5.

7.1.5.1 Commissioning of *protection*

(a) The *Network Operator reserve*s the right to witness the commissioning tests on any of the *User's protection* that it deems to be important or critical for the *reliable* operation and integrity of the *Network Operator power system*.

(b) The *User* shall pay *Network Operator's* reasonable costs associated with the witnessing of the commissioning tests.

(c) 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.

8 *Disconnection* and re*connection* of *plant* and equipment

8.1.1 Voluntary *disconnection*

(a) Unless agreed otherwise and specified in a~~n Access Agreement~~*connection agreement*, a *User* shall give to the *Network Operator* notice in writing of its intention to permanently *disconnect* a *facility* from a *connection point*.

(b) A *User* is entitled, subject to the terms of the relevant ~~*Access Agreement*~~*connection agreement*, to require voluntary permanent *disconnection* of its equipment from the *power system* in which case appropriate operating procedures necessary to ensure that the *disconnection* will not threaten *power system security* shall be implemented in accordance with clause 8.1.2.

(c) The *User* shall pay all costs directly attributable to the voluntary *disconnection* and *decommission*ing.

8.1.2 *Decommissioning* procedures

(a) In the event that a *User's facility* is to be permanently *disconnect*ed from the *power system*, whether in accordance with clause 8.1.1 or otherwise, the *Network Operator* and the *User* shall, prior to such *disconnection* occurring, follow agreed procedures for *disconnection*.

(b) The *Network Operator* shall notify other *Users* if it believes, in its reasonable opinion, the terms and conditions of such a~~n *Access Agreement*~~*connection agreement* will be affected by procedures for *disconnection* or proposed procedures agreed with any other *Users* The parties shall negotiate any amendments to the procedures for *disconnection* or the ~~*Access Agreement*~~*connection agreement* that may be required.

(c) Any *disconnection* procedures agreed to or determined under clause 8.1.2(a) shall be followed by the *Network Operator* and all *Users*.

8.1.3 Involuntary *disconnection* (refer also to clause 4.7)

(a) The *Network Operator* may *disconnect* a *User's* facilities from a *network*:

(1) during an emergency in accordance with clause 8.1.5;

(2) in accordance with relevant laws; or

(3) in accordance with the provisions of the *User's* ~~*Access Agreement*~~*connection agreement*.

(b) In all cases of *disconnection* by the *Network Operator* during an emergency in accordance with clause 8.1.5, the *Network Operator* is required to undertake a review under clause 4.7.11 and the *Network Operator* shall then provide a report to the *User* advising of the circumstances requiring such action.

8.1.4 *Disconnection* due to breach of a~~n~~ ~~*Access Agreement*~~*connection agreement*

(a) Subject to the relevant provisions the *Network Operator* may *disconnect* a *User's* facilities from a *network* if in the *Network Operator's* reasonable opinion, the *User* has breached a term of the ~~*Access Agreement*~~*connection agreement* and such breach poses a threat to *power system security*. In such circumstances the *Network Operator* will not be liable in any way for any loss or damage suffered or incurred by the *User* by reason of the *disconnection* and the *Network Operator* will not be obliged for the duration of the *disconnection* to fulfil any agreement to convey electricity to or from the *User's facility*.

(b) A *User* shall not bring proceedings against the *Network Operator* to seek to recover any amount for any loss or damage described in clause 8.1.4(a).

(c) A *User* whose facilities have been *disconnect*ed under this clause 8.1.4 shall pay charges in accordance with the *Network* Pricing and Charges Schedule as if any *disconnection* had not occurred.

8.1.5 *Disconnection* during an emergency

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

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

(b) Immediately *disconnect* the *User's* facilities by automatic or manual means where, in the *Network Operator's* reasonable opinion, it is not appropriate to follow the procedure set out in clause 8.1.5(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*.

8.1.6 Obligation to re*connect*

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

(a) *Disconnection* of the *User* during an emergency has taken place in accordance with clause 8.1.5.

(b) A breach of this *Code* or ~~*Access Agreement*~~*connection agreement* giving rise to *disconnection* has been remedied; or

(c) Where the breach is not capable of remedy, compensation has been agreed and paid by the *User* to the affected parties or, failing agreement, the amount of compensation payable has been determined in accordance with the dispute resolution process described in clause 1.6 and that amount has been paid; or

(d) Where the breach is not capable of remedy and the amount of compensation has not been agreed or determined, assurances for the payment of reasonable compensation have been given to the satisfaction of the *Network Operator* and the parties affected; or

(e) The *User* has taken all necessary steps to prevent the re-occurrence of the breach and has delivered binding undertakings to the *Network Operator* that the breach will not reoccur.

9 Operation of *Generators connected* to the *network*

9.1 *Power system security* related market operations

9.1.1 *Dispatch* related limitations

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

(a) *Dispatch* any *energy* from a *generating unit* ~~*Generation Unit,*~~ except:

(1) in accordance with the procedures specified in this *Code* and its Technical Requirements for *connection*; or

(2) in accordance with an instruction from the *Power System Controller*; or

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

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

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

(b) Adjust the *transformer tap position* or *excitation control system voltage* set-point of a *scheduled generating unit* ~~*Generation Unit*~~ except:

(1) in accordance with an instruction from or by agreement with the *Network Operator;* or

(2) in response to remote control signals given by the *Network Operator* or its agent; or

(3) if, in the scheduled *User's* reasonable opinion, the adjustment is urgently required to prevent material damage to the *User's plant* or associated equipment, or in the interests of safety; or

(4) in *connection* with a test agreed with the *Network Operator* and conducted in accordance with this *Code* or procedures agreed with the *Network Operator*.

(c) *Energise* a *connection point* in relation to a *User's generating unit* ~~*Generator unit*~~ without prior approval from the *Network Operator*. This approval shall be obtained immediately prior to *energisation*;

(d) *Synchronise* a *scheduled generating unit* ~~*Generation Unit*~~ to, or de-*synchronise* a *scheduled generating unit* ~~*Generation Unit*~~ from, the *power system* without prior approval from the *Power System Controller* except *de-synchronisation* as a consequence of the operation of automatic *protection* equipment or where such action is urgently required to prevent material damage to *plant* or equipment or in the interests of safety;

(e) *Change* the *frequency response mode* of a *scheduled generating unit* ~~*Generation Unit*~~ without the prior approval of the *Network Operator;* or

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

See also clauses 3.3 and 4.2 of Version 4.0 of the *System Control Technical Code*.

9.1.2 [Deleted] ~~*Commitment of Generation Units*~~

[Deleted] ~~In relation to any *User's Generation Unit*, the *User* shall confirm with the *Power System Controller*, the expected synchronism *time* at least one hour before the expected actual *synchronising time*, and update this advice 5 minutes before *synchronising* unless otherwise agreed with the *Power System Controller*. The *Power System Controller* may require further notification immediately before *synchronisation*.~~

9.1.3 ~~De-*commitment*, or output reduction, by *Users* requiring *standby power*~~

~~(a) Any *User* requiring *standby power* from a *Generator* or the *Network Operator* shall notify the *Power System Controller* well in advance. To do this a *User* will have to both apply for it and include it in the *outage* and production plans they submit to the *Power System Controller*.~~

~~(b) A *User* shall confirm with the *Power System Controller* the expected *de-synchronising time* at least one hour before the expected actual *de-synchronising time*, and update this advice 5 minutes before *de-synchronising* unless otherwise agreed with the *Power System Controller*. The *Power System Controller* may require further notification immediately before *de-synchronisation*.~~

~~(c) Information to be confirmed with the *Power System Controller* to de-commit a *User's Generation Unit* if there is to be no automatic and coincident reduction in the *User's associated load* shall include:~~

~~(1) the *time* to commence decreasing the output of the *Generation Unit*;~~

~~(2) the *ramp rate* to decrease the output of the *Generation Unit*;~~

~~(3) the *time* to de-*synchronise* the *Generation Unit*; and~~

~~(4) the output from which the *Generation Unit* is to be de-*synchronised*~~

~~(d) Any *User* not requiring *standby power* that wishes to take a *Generator* out-of-service shall first reduce the *associated load demand* by an amount equal to the *Generator* output to be reduced. Once the *demand* has been reduced, the *Generator's load* may be reduced. Clearance shall be obtained from the *Power System Controller* before commencing this exercise.~~

9.2 *Users' plant changes*

A *User* shall, without delay, notify the *Power System Controller* of any event which has *change*d or is likely to *change* the operational availability or *load* following capability of any of its *generating units*~~*Generation Units*~~, whether the relevant *generating unit* ~~*Generation Unit*~~ is *synchronise*d or not, as soon as the *User* becomes aware of the event.

9.3 Operation, maintenance and *extension* planning

Operation, maintenance and *extension* planning and co-ordination shall be performed in accordance with this *Code* and any applicable ~~*Access Agreement*~~*connection agreement*.

9.4 ~~Generating limits~~[Deleted]

~~Limits to the VAr *Generation* and absorption capability of *Generation Facilities* and reactive compensation *plant* such as *static var compensators* shall not be exceeded.~~

10 ~~*Metering* requirements~~ [Deleted] ~~applicable until 1 July 2019]~~

~~This clause 10 applies to all *Users* at any *revenue metering point* through which *energy* is transferred to or *energy* is taken from the *Network Operator's electricity network*.~~

~~***This clause is superseded from 1 July 2019 by NT NER Chapter 7A.***~~

~~10.1 Purpose of *metering* clause~~

~~(a) The purpose of clause 10 is to set out the rights and obligations of *Users* and the *Network Operator*.~~

~~(b) Clause 10 sets out provisions relating to:~~

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

~~(2) *check metering installations*;~~

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

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

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

~~(6) testing requirements;~~

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

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

~~10.2 *Metering* principles~~

~~The key *metering* principles are as follows:~~

~~(a) Each *connection point* shall have a *revenue metering installation*.~~

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

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

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

~~(e) The *Network Operator* may offer to install a check meter, or check meters, or check *metering*, and commission and maintain check *metering* on behalf of the *User*.~~

~~(f) The *Network Operator* will own the *revenue metering installation* and the *User* may be required to make a non-refundable contribution to the cost of the installation.~~

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

~~(h) The *Network Operator* shall ensure that the accuracy of each component of a *revenue metering installation* complies with its accuracy class.~~

~~(i) *Energy data* is to be based on units of watt-hours *active energy* and var-hours *reactive energy*.~~

~~(j) The *Network Operator* will make *revenue metering data* available to Each *User*, subject to confidentiality requirements.~~

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

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

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

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

~~10.3 Responsibility for *metering* installation~~

~~10.3.1 Responsibility of the *Network Operator*~~

~~(a) No later than 20 *business days* after receiving a request for the provision of a *revenue metering installation*, or a *revenue metering installation* and a *check metering installation* from a prospective *User*, the *Network Operator* shall provide a quotation and any conditions on which the offer is made~~

~~(b) The *Network Operator* will advise the *User* of its right to provide and install certain *revenue metering* components in accordance with Attachment 4 and the *Network Operator 's Metering* Manuals, Underground Manual and Overhead Line Manual.~~

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

~~10.3.2 *User* elects to provide and install certain *metering* components~~

~~(a) If the *User* does not accept the offer made by the *Network Operator* to provide a *revenue metering installation*, the *User* will be responsible for the provision and installation of the *revenue metering*, except for the *revenue*~~

~~*meters* in accordance with Attachment 4 and the *Network Operator's metering manuals* and the check *metering*, if required by the *User*.~~

~~(b) The *Network Operator* will provide and install the *revenue meters*, commission the installation and provide ongoing maintenance of the *revenue metering installation* in accordance with Attachment 4 and the *Network Operator's metering manuals*.~~

~~10.3.3 Other responsibilities~~

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

~~(b) The *User*, if providing and installing *revenue metering equipment*, shall ensure that the equipment complies with Attachment 4 and the *Network Operator's metering manuals*.~~

~~(c) Prior to installation, the equipment that is involved in measurement of *energy*, other than the check meters shall be submitted to the *Network Operator* for testing for compliance with the *Network Operator's metering manuals*.~~

~~10.4 *Metering* installation arrangements~~

~~10.4.1 *Metering* installation components~~

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

~~(b) A *revenue metering installation* shall:~~

~~(1) contain a measuring device for active and *reactive energy* and a visible display of all *revenue metering data* as per Australian Standard AS1284;~~

~~(2) be accurate in accordance with Attachment 4;~~

~~(3) have electronic data transfer facilities;~~

~~(4) be secure in accordance with the *Network Operator's metering manuals*;~~

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

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

~~(7) be capable of providing *revenue metering data* to a communication system; and~~

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

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

~~(1) *current transformer*;~~

~~(2) *voltage transformers*;~~

~~(3) secure and protected wiring;~~

~~(4) *revenue meter* panels on which the *revenue meters* and communication equipment are mounted;~~

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

~~(6) test links and fusing;~~

~~(7) *energy* and status signals;~~

~~(8) summation equipment;~~

~~(9) *revenue metering* enclosure;~~

~~(10) marshalling boxes; and~~

~~(11) *revenue metering* unit.~~

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

~~10.4.2 *Metering for connection of Small Inverter Energy Systems*~~

~~(a) A *User* with a *Small Inverter Energy System* shall make provision for both an import and export meter.~~

~~(b) Should an additional meter be required for the export power meter, the *User* may need to install an additional meter box or rearrange the existing meter box to accommodate a second meter.~~

~~10.4.3 Use of meters~~

~~(a) *Revenue metering data* will be used by the *Network Operator* as the primary source of billing data.~~

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

~~(1) validation;~~

~~(2) substitution; and~~

~~(3) account estimation~~

~~of *revenue metering data* as required by clause 10.9.4.~~

~~**10.4.4 *Metering* type and accuracy**~~

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

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

~~(c) If the *User* elects to provide separate *current transformers* and *voltage transformers* they shall comply with clause 10.3.3.~~

~~**10.4.5 Data collection system**~~

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

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

~~(c) The *Network Operator* may obtain *revenue metering data* directly from a *revenue metering installation*.~~

~~**10.4.6 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, down*load*ing of *revenue metering data*, processing and account resolution for a *revenue metering installation*.~~

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

~~**10.5 Register of *metering* information**~~

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

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

~~10.5.1 Meter register discrepancy~~

~~(a) If a discrepancy is noted between the *User's* installation and the *revenue metering register*, the *Network Operator* shall correct the discrepancy within 2 *days*.~~

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

~~10.6 Testing of *metering* installation~~

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

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

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

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

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

~~10.6.1 Actions in event of non-compliance~~

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

~~(b) The *Network Operator* shall in conjunction with the *User* make appropriate corrections to the *revenue metering data* to take account of any errors as a result of the non-compliance found in 10.6.1(a).~~

~~10.6.2 Audits of *metering* data~~

~~(a) A *User* may request the *Network Operator* to conduct an audit to determine consistency between the data held in the *revenue metering database* and the *revenue metering data* held in the *User's revenue metering installation*.~~

~~(b) If there is an inconsistency between the data held in a *revenue metering installation* and the data held in the *revenue metering database*, the data held~~

~~in the *revenue metering installation* is to be taken as prima facie evidence of the *revenue metering data*.~~

~~10.7 Rights of access to *metering* data~~

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

~~(1) the *Network Operator*; and~~

~~(2) the *User* whose account statement relates to *energy* measured at that *revenue metering point*.~~

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

~~10.8 Security of *metering* installations~~

~~10.8.1 Security of *metering equipment*~~

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

~~10.8.2 Security controls~~

~~(a) The *Network Operator* is responsible for the security of *revenue metering data* held in the *revenue metering installation* and shall prevent local or remote access by suitable passwords and/or other security devices in accordance with clause 10.8.1.~~

~~(b) The *Network Operator* shall keep records of electronic passwords secure.~~

~~(c) The *Network Operator* may allocate a "read-only" password to a *User* where the *revenue meters* installed have provision for multi-level passwords.~~

~~10.8.3 *Changes* to *metering equipment*, parameters and settings~~

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

~~10.9 Processing of *metering* data for settlement purposes~~

~~10.9.1 *Metering* databases~~

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

~~(b) The *revenue metering database* shall include original *energy* readings and substitute calculated values where estimates may be required.~~

~~**10.9.2 Remote acquisition of data**~~

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

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

~~**10.9.3 Periodic *energy metering***~~

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

~~**10.9.4 Data validation and substitution**~~

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

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

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

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

~~**10.9.5 Errors found in *metering* tests, inspections or audits**~~

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

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

~~10.9.6 *Load* following and out of balance *energy*~~

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

~~10.10 Confidentiality~~

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

~~10.11 Meter *time*~~

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

~~(b) The *revenue metering database* shall be set within an accuracy of ±10 seconds of Australian Central Standard *Time*.~~

11 Information requirements for *network connection*

11.1 Scope

(a) The following information requirements apply to the *connection* of *Users* to the *Power and Water network*s.

(b) The *Network Operator* is obliged to obtain sufficient information in respect of a *network connection* to enable the *Network Operator* to ensure that the relevant *User connection* will not prevent the *network* performance standards in clause 2 of the *Code* from being met.

(c) If, in the opinion of the *Network Operator*, additional information for a particular *User connection* is required to ensure the *network* performance standards in clause 2 of the *Code* are met, the *User* shall *supply* the additional information.

(d) The *User* shall provide all data reasonably required by the *Network Operator*.

(e) Particular provisions may be waived for smaller *Users* and *Users* that have no potential to affect other *Users*, at the discretion of the *Network Operator*, in accordance with the *derogation* provisions of clause 12.

(f) Nothing in this section waives the requirements for all installations to comply with the *Network Operator's* Service and Installation Rules, *Metering* Manual, Contractor's Bulletins, and any requirement included in a~~n~~ ~~*Access Agreement*~~*connection agreement*.

11.2 Information to be provided by all *Network Users*

11.2.1 Information on *connect*ed *plant*

(a) Before any new or additional equipment is *connect*ed, the *User* may be required to submit the following kinds of information to the *Network Operator*:

(1) a single line diagram with the *protection* details;

(2) *metering* system design details for equipment being provided by the *User*;

(3) a general arrangement locating all the equipment on the site;

(4) a general arrangement for each new or altered *substation* showing all exits and the position of all electrical equipment;

(5) type test certificates for all new switchgear and *transformer*s, including measurement *transformer*s to be used for *metering* purposes in accordance with clause 10 (*metering*) of this *Code*;

(6) the proposed methods of earthing cables and other equipment to comply with the Electricity Supply Association of Australia Substation Earthing Guide, or *Australian Standard* AS3000, or both, as appropriate;

(7) *plant* and earth grid test certificates from approved test authorities;

(8) a primary/secondary injection test of *protection* and trip test certificates on all circuit breakers;

(9) certification that all new equipment has been inspected before being *connect*ed to the *supply*;

(10) operational procedures;

(11) calculated maximum *demand* of the installation;

(12) details of potentially disturbing *load*s; and

(13) SCADA arrangements.

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

11.2.2 Details of proposed *Users' protection*

(a) Unless otherwise agreed by the *Network Operator, Users* shall provide the *Network Operator* with full details of proposed *protection* designs, together with all relevant *plant* parameters, a minimum of 12 *month*s prior to *energisation* of the protected *primary plant*.

(b) The *Network Operator* shall provide comments on a *User's* proposed *protection* designs within 65 *business day*s, unless otherwise agreed.

11.2.3 Requirements where a *critical fault clearance time* exists

(a) Where a *critical fault clearance time* exists, *Users* shall maintain a record of design *fault clearance times* for all circuit breakers within their *plant*.

(b) Records of design *fault clearance times* shall be made available to the *Network Operator* on request.

11.3 ~~Information to be provided by *Users* with *Generators*~~[Deleted]

~~(a) A *User* with a *Generator* shall provide the data specified in clause 11.2.~~

~~(b) The *User* shall provide all other data reasonably required by the *Network Operator*. This data shall include, without limitation, full models (and all model parameters) of:~~

~~(1) the *Generation Units*;~~

~~(2) the *excitation control systems*;~~

~~(3) turbine / engine *governor systems*; and~~

~~(4) *power system stabilisers*;~~

~~(5) to enable the *Network Operator* to conduct dynamic simulations.~~

~~(c) These models shall be in a form which is compatible with the *power system* analysis software used by the *Network Operator* (currently PSS/E from Siemens PTI) and shall be inherently stable.~~

~~(d) Details of the kinds of data that may be required are included in Attachment 3 of this *Code*, specifically:~~

~~(1) Schedule S3.1 - *Generation Unit* design data;~~

~~(2) Schedule S3.2 - *Generation Unit* setting data;~~

~~(3) Schedule S3.5 - *Network* and *plant* technical data; and~~

~~(4) Schedule S3.6 - *Network plant* and apparatus setting data.~~

11.4 Information to be provided by *Users* with *Small Generators*

(a) A *User* with a *Small Generator* shall provide the data specified in clause 11.2.

(b) A *Small Generator* shall provide all information in relation to the design, construction, operation and configuration of that small *power station* as is required by the *Network Operator* to ensure that the operation and performance standards of the *network*, or other *Users*, are not adversely affected by the operation of the *power station*.

(c) In order to assess the impact of the equipment on the operation and performance of the *network* or on other *Users*, the *Network Operator* may require a *Small Generator* to provide data on:

(1) *power station* and *generating unit* ~~*Generation Unit*~~ aggregate real and *reactive power*; and

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

(d) Net import / export data shall be provided in the form of:

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

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

(e) When requested by the *Network Operator*, a *Small Generator* shall provide details of the proposed operation of the equipment during start-up, shut-down, normal daily operation, intermittent fuel or wind variations and under fault or emergency conditions.

(f) Details of the kinds of data that may be required are included in Attachment 3 of this Code, specifically:

(1) Schedule S3.3 - *Generator* data for small *generating systems*~~Small *Generation Units*~~;

(2) Schedule S3.5 - *Network* and *plant* technical data; and

(3) Schedule S3.6 - *Network plant* and apparatus setting data.

11.5 Information to be provided by *Users* with *Small Inverter Energy Systems*

A *Small Inverter Energy System* may be installed as an addition to an existing *load connection*, in conjunction with a new *load connection* or as a stand-alone *Generation* system.

(a) A *User* with a *Small Inverter Energy System* shall provide the data specified in clause 11.2.

(b) Details of the kinds of data that may be required from a *User* with a *Small Inverter Energy System* are included in Attachment 3 of this *Code*, specifically:

(1) Schedule S3.4 - Technical data for *Small Inverter Energy Systems*;

(2) Schedule S3.5 - *Network* and *plant* technical data;

(3) Schedule S3.6 - *Network plant* and apparatus setting data; and

(4) Schedule S3.7 - *Load* characteristics at *connection point*.

11.6 Information to be provided by *Users* with *loads*

(a) A *User* with a ~~*Load*~~ *load* shall provide the data specified in clause 11.2.

(b) Details of the kinds of data that may be required from a *User* with a *Load* are included in Attachment 3 of this *Code*, specifically:

(1) Schedule S3.5 - *Network* and *plant* technical data;

(2) Schedule S3.6 - *Network plant* and apparatus setting data; and

(3) Schedule S3.7 - *Load* characteristics at *connection point*.

12 Transitional arrangements and d~~D~~erogations from the *Code*

12.1 Purpose and application

(a) This clause 12 prevails over all other clauses of this *Code*.

(b) *Derogation*s of *Users* are:

(1) those provisions of the other clauses 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) *Derogation*s are for the purpose of:

(1) enabling *Users* to effect an orderly transition to the provisions of the *Code* from those provisions currently applying (including extension of a grace period set out in Schedule S4);

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

(3) providing specific exemptions from the *Code* for future arrangements (implemented after the introduction of a new version of this *Code*) that the *Network Operator* determines to be acceptable.

(d) The *Network Operator* is not required to grant a *derogation* if doing so will adversely affect *network capability*, *power system security*, quality or reliability of *supply*, *intra-regional power transfer capability* or the use of a *network* by another *User.*

(e) An applicant for a *derogation* must submit that application in such form reasonably required by the *Network Operator* which application must outline:

(1) the nature of the *derogation* sought;

(2) why the *derogation* should be granted;

(3) why granting of the *derogation* will not have the effect referred to in clause 12.1(d).

(f) Applications for *derogations* under clause 12.1(b)(1) and (2) may be granted if the *Network Operator* in good faith forms the view that the *derogation* is appropriate given the pre-existing arrangements to which the *User* is party and having regard to the criteria in clause 12.1(d).

(g) In considering applications under clause 12.1(b)(3) the *Network Operator* must apply the principle that *Users* first applying to *connect* to the *electricity network* after the commencement of version [4] of this *Code* should comply with the standards in this *Code* and that *derogations* should only be granted to small *Users* who have only minor impact upon the *electricity network* (including when their impact is aggregated with other small *Users*) or where there are otherwise compelling reasons for granting the *derogation*.

~~(d)~~(h) Applications for *derogations* shall be submitted to and processed by the *Network Operator* in accordance with any requirement of applicable laws~~the *Electricity Networks (Third Party Access) Act 2011*~~.

12.2 *Pre 1 April 2019 plant and equipment* ~~**Networks and facilities existing atpre and post 1 April 2019September 2012**~~

~~*Users* of All *plant* and equipment in the *Network* and all facilities *connect*ed to this *network* existing at 1 September 2012April 2019 are required:~~

~~as a minimum, to demonstrate compliance with the version of this *Code* in force prior to 1 April 2019 (Version 3.1); and~~

~~to document the performance capability of the *plant* and equipment using an agreed methodology and within the timeframe agreed between the *User* and *Network Operator*.~~

~~The relevant *User* shall be responsible for demonstrating compliance and remedying any non-compliance at the *User's* cost.~~

~~*Users* of *plant* and equipment meeting the requirements of paragraph (a) will be deemed to comply with this *Code*.~~

~~*Users* modifying *plant* and equipment are required to meet the requirements of this *Code*~~

~~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.~~

(a) This clause applies to *plant* of a *Generator User connected* to the *electricity network* prior to 1 April 2019 (such *plant and equipment* being ***Existing Connection Plant***).

(b) A *Generator User* to whom this clause applies must, in respect of the *Existing Connection Plant*:

(i) comply with the technical standards applicable to such *Existing Connection Plant* under Version 3 of this *Code* (as in force immediately prior to the date Version 4 of this *Code* came into effect); and

(ii) comply with clause 3 of this *Code* (Technical requirements for equipment *connected* to the *network*) including the *automatic access standards* set out in that clause 3 to the extent the *Existing Connection Plant* is able (without requiring modification, alteration or enhancement) to comply with that clause and those *automatic access standards*.

(c) A *Generator User* to whom this clause applies must, if required by the *Network Operator*, conduct such tests as required by the *Network Operator* to determine the extent to which the *Existing Connection Plant* of the *Generator User* is able to comply with clause 3, including the *automatic access standards*. Such tests must be conducted at the times and otherwise in accordance with the requirements reasonably determined by the *Network Operator*.

(d) The *Generator User* must report the results of the tests to the *Network Operator* in such manner specified by the *Network Operator* acting reasonably.

(e) The *Generator User* must bear its own costs of undertaking the tests required by the *Network Operator* and must reimburse the *Network Operator*, at such times reasonably determined by the *Network Operator*, the *Network Operator's* reasonable costs of conducting and overseeing such tests.

(f) If a *Generator User* materially modifies, alters or enhances *Existing Connection Plant*, then it must do so in accordance with any applicable provisions of the *NT NER* and this *Code* (including where required by this *Code* complying with the *automatic access standards* or such *negotiated access standards* as may be agreed).

12.3 Post 1 April 2019 plant and equipment

(a) This clause applies to a *Generator User* who has entered into a connection agreement with the *Network Operator* prior to Version 4 of this Code coming into effect but had not completed the *connection* of *plant and equipment* to the *electricity network* prior to 1 April 2019.

(b) Subject to this clause 12.3, such *Generator User* must ensure all *plant and equipment connected* to the *electricity network* pursuant to that *connection agreement* complies with the requirements of this *Code* including (subject to paragraph (c) below) the *automatic access standards.* However where a grace period for a technical requirement is specified in Schedule S4 a *Generator User* will not be regarded as in breach of this *Code* if:

(i) within 30 days of commencement of version [4] of this *Code* it submits to the *Network Operator* a written communication confirming each ~~automatic access standard~~*automatic access standard* that is met, and for each individual ~~automatic access standard~~*automatic access standard* that is not met, a plan setting out the procedures, consistent with *good electricity industry practice*, which will be followed by the *Generator User* to ensure it complies with that technical requirement from the end of the applicable grace period; and

(ii) it complies with that plan; and

(iii) it ensures it complies with that technical requirement as soon as reasonably practicable and in any event from the end of the relevant applicable grace period.

(c) A plan submitted under clause 12.3(b):

(i) may include a process for negotiating a *negotiated access standard*; and

(ii) must include the testing and commissioning procedures which will be followed by the *Generator User* to establish it has achieved compliance with each relevant technical requirement.

(d) A *Generator User* must make such changes to a plan submitted under clause 12.3(b) as reasonably required by the *Network Operator*.

(e) A *Generator User* to whom this clause applies may request the *Network Operator* to agree with it a *negotiated access standard* in substitution for an *automatic access standards* and, if so, the *Network Operator* will negotiate in good faith with the *Generator User* to agree such *negotiated access standard* in accordance with the criteria set out in clause 3.3.5. The *Generator User* must, at such times reasonably determined by the *Network Operator*, reimburse the *Network Operator* its reasonable costs of undertaking any such negotiations. Until such time as a *negotiated access standard* is agreed, any *connected plant* of the *Generator User* must, subject to clause 12.3(b), comply with the *automatic access standard*.

(f) Where this *Code* contemplates a matter being agreed between the *Network Operator* and the *Generator User* and such matter is not specified in the *connection agreement* then:

(i) the *Network Operator* may, as a condition to connecting the *plant* to the *electricity network* and permitting its commissioning, require that the *Network Operator* and the *Generator User* agree such matters and document them as an amendment to the connection agreement; or

(ii) if the *plant* is already *connected* and commissioned as at the time Version 4 of this *Code* comes into effect, the *Generating User* must, if required by the *Network Operator*, negotiate in good faith to agree and document such matters by an amendment to the *connection agreement* (and if such matters are not agreed within 4 months of the *Network Operator's* request then the matter may be referred for determination by the *Utilities Commission* under clause 1.6(b)).

(g) The *Generator User* must, at such times reasonably determined by the *Network Operator*, reimburse the *Network Operator* its reasonable costs of negotiating and documenting the matters referred to in clause 12.3(f).

(h) The *Generator User* must report the results of the tests conducted in accordance with a plan referred to in clause 12.3(b) to the *Network Operator* in such manner specified by the *Network Operator* acting reasonably. The *Generator User* must bear its own costs of undertaking such tests and must reimburse the *Network Operator*, at such times reasonably determined by the *Network Operator*, the *Network Operator's* reasonable costs of conducting and overseeing such tests.

Part C *Network Planning Criteria*

Power and Water is the major custodian and operator of the power *network*s within the Northern Territory. *Power and Water* is responsible for the *network* security, *reliability* and *quality of supply* to all *Network Users*. *Power and Water*'s technical requirements are intended to ensure that a high *reliability* of service is maintained when additions and *change*s to the *network*s or *Users'* installations are made. Technical requirements are based on the rules, criteria and limits included in the *Technical Code* and these *Network Planning Criteria*.

The *Network Planning Criteria* ~~provide for the requirements of the legislated Third Party Access regime, which permits~~ allow *network customer*s to use *Power and Water*'s regulated *network*s to enable contracted trade between *Generator Users* and *customer Users*.

The purpose of *Network Planning Criteria* is to strike a balance between each *User's* need for a safe, secure, *reliable*, high quality electricity *supply* and the desire for this service to be provided at minimal cost. At the same *time*, environmental and social considerations shall be taken into account.

13 Introduction

(a) Additions to and reinforcement of the *network*s in the form of additional:

(1) *Transmission line*s and *distribution* feeders;

(2) *Transformer*s;

(3) *Generator*s;

(4) *Load*s; and

(5) Capacitors or *reactor*s;

will produce an impact on the existing *network*s and *customer*s.

(b) This Part C presents the *Planning Criteria* applied to ensure that *Power and Water*'s *network*s:

(1) Provide a high quality electricity *supply*;

(2) Provide a *reliable* electricity *supply*;

(3) Provide a secure electricity *supply*;

(4) Meet safety standards;

(5) Meet environmental standards;

(6) Optimise equipment utilisation; and

(7) Optimise *network losses*.

(c) The philosophy of *network* planning and the rationale behind the *Planning Criteria* are discussed in clause 13.1 of this document.

(d) The guidelines for *network* planning, which are provided in this document, outline the range of technical and environmental *Planning Criteria*.

13.1 *Network* design philosophy

(a) The *Planning Criteria* are used to assess the *supply* system capacity and determine the need for and timing of:

(1) *Generation* support;

(2) *Demand* management;

(3) *Network* reinforcement; or

(4) *Network* re-configuration;

to meet *customers' demand* for electricity.

(b) *Network* reinforcement plans may then be developed which will satisfy the *Planning Criteria* and environmental *constraints*.

13.2 Amendments to the *Planning Criteria*

(a) Any *User* ~~*System Participant*~~ may propose an amendment to the *Planning Criteria*.

(b) A proposal to amend the *Planning Criteria* shall be made in writing by the ~~*System Participant*~~*User* to the *Network Operator* and shall be accompanied by:

(1) the reasons for the proposed amendment to the *Planning Criteria*; and

(2) an explanation of the effect on ~~*System Participants*~~*Users* of the proposed amendment to the *Planning Criteria*.

(c) Subject to paragraph (f) below, t~~T~~he *Network Operator* shall review the proposed amendment to the *Planning Criteria* and within 30 days advise the ~~*System Participant*~~*User* or electricity entity:

(1) whether the proposed amendment to the Planning Criteria is accepted or rejected; and

(2) the reasons for the acceptance or rejection of the proposed amendment to the Planning Criteria.

(d) The 30 day period in clause 13.2(c) is extended as reasonably required to allow any public consultation or consultation with the Utilities Commission required under the *Electricity Reform Act*.

~~(d)~~(e) The *Network Operator* shall review the operation of the *Planning Criteria* at intervals of no more than 5 years and may seek submissions from ~~*System Participants*~~*Users* and the Utilities Commission during the course of the review.

~~(e)~~(f) The *Network Operator* may amend this *Planning Criteria* in accordance with the legislative provisions.

13.3 132 kV and 66 kV *network*s

The traditional planning philosophy for a meshed *network* has been that the loss of any one component of the *network* at a *time* of *peak load* will not result in the loss of *supply* to any *customer*s. This is the *'*n-1*'* criterion, which can result in imprudent capital expenditure if the *frequency* and consequences of breaching the criterion are not considered. Prudent capital expenditure involves the application of risk management techniques. This requires a consideration of the probability of an event occurring and the consequences of its occurrence, for example the impact on *customer*s. If the probability of the event is low and the consequences acceptable, it may be considered justified to delay system reinforcement beyond the date indicated by the n-1 criterion and *peak load*ing.

(a) *Power and Water* designs its 132 kV and 66 kV systems as meshed *network*s.

(b) There may be radial 132 kV and 66 kV lines extending from the meshed *network* to many rural and developing areas.

(c) *Generators* are connected to the *networks* at voltages of 132 kV and 66 kV. The technical characteristics of *Generator* connections may be negotiated with the *Generator* provided that the *network* performance standards of clause 2 of the *Network Technical Code* are maintained.

13.4 *Distribution network*s

Power and Water designs its *distribution network*s as radial systems.

13.4.1 CBD area

(a) In the Darwin central business district, five 11 kV switching stations *supply* a *network* of underground HV feeder rings, with open points approximately mid-way between switching stations [1].

(b) The switching stations are remotely controlled, but the intermediate switches used to transfer *load* and restore *supply* in the event of a *supply* contingency are operated manually.

13.4.2 Urban areas

(a) In urban areas the lower density of *Users* generally results in an open, meshed *network* of HV feeders run radially with open points.

(b) This operating mode minimises fault levels and simplifies technical and operational requirements.

[1] Power and Water's High *Voltage* (HV) networks operate at *voltage* levels of 22 kV in rural areas and 11 kV in urban areas.

(c) In these situations, the extent of the loss of *supply* can be minimised by the use of reclosers and sectionalisers to limit the impact of faults and the speed of restoration improved through the use of fault indicators to locate faults.

13.4.3 Rural areas

(a) In rural areas the *distribution network* is generally radial and *interconnection* to reduce *supply* restoration times is often not possible.

(b) In normal circumstances the loss of a component of the *network* will result in the loss of *supply* to a number of *Users* until the *network* is reconfigured or repaired.

13.4.4 Enhanced security of *supply*

(a) The *Network Operator* will provide for the reasonable request of a *User* requiring additional security of *supply* above the standard design philosophy.

(b) Additional costs incurred in providing the additional security of *supply* would ordinarily be charged to the *User*.

(c) In some circumstances, on-site standby ~~*Generation*~~ *generation* may be the only economic or practical alternative to improve *supply* security.

13.4.5 Embedded *generation*

(a) The *distribution network* is not designed to support the islanded operation of *embedded Generators* and *Power and Water's distribution* equipment is not normally fitted with *synchronising* equipment.

(b) Embedded ~~*Generation Units*~~*generating units*, including small solar photo-voltaic and wind *Generators* at *Network Users'* premises shall be of a design that automatically *disconnects* from the *network* if the *distribution* feeder that they are *connected* to is separated from the remainder of the *power system*.

(c) The requirements concerning the *connection* of *Small Generators* and *Small Inverter Energy Systems* are set out in clauses 3.4 and 3.5 of this ~~e *Network Technical*~~ *Code*.

13.5 Process to assess the need for *network* reinforcement

(a) *Network* capacity and the need for *network* reinforcement are assessed by comparing the *Planning Criteria* with *network* performance for:

(1) Increasing *load* levels;

(2) Changing *load demand* patterns;

(3) Particular *load* characteristics; and

(4) *Reliability*.

(b) To satisfy the performance levels, be they *reliability*, security, or quality levels, least cost and effective plans are developed. The extent of the *network* reinforcement works is dependent on:

(1) The *load* forecast;

(2) The anticipated maximum *demand*s of all *Users*;

(3) Special conditions of the *User's load*;

(4) The anticipated minimum *demand* of other *Users*;

(5) *Users' load* profiles;

(6) The availability of non-*network* alternatives to *network* reinforcement; and

(7) The age and condition of existing assets.

(c) Economic analysis is used in assessing *network* reinforcement requirements and serves four functions as it:

(1) Indicates the return to *Power and Water* of proposed capital investment;

(2) Helps to choose between options;

(3) Helps rank the project with other projects *generated* throughout *Power and Water*; and

(4) Ensures the equitable allocation of costs between *Users*.

(d) In some cases, *network* reinforcement works may also be justified on an economic basis where there are immediate benefits in return for capital invested, eg. *network* loss optimisation.

13.6 The process of developing *network* concept plans

(a) *Power and Water*, in developing *network* concept plans for the long-term development of the *network*, uses ultimate *load* horizon planning.

(b) In this methodology *Power and Water* considers the following information in assessing the ultimate *load* for an area:

(1) Department of Lands Planning and Environment land use structure plans;

(2) Australian Bureau of Statistics censuses;

(3) Consultants' reports on population growth in the major centres;

(4) Any relevant town planning schemes;

(5) Local Government advice on future planning proposals;

(6) Geographic features and their associated design limitations; and

(7) Any environmental *constraint*s, including vegetation and ecology limitations.

(c) This information is combined with any other available future *load* information to produce an ultimate *load* assessment for an area and on the basis of this a *network* concept plan is developed.

13.7 *Planning Criteria*

Planning Criteria are a set of standards applied to maintain appropriate levels of *network* security and *reliability*. They are used as a planning and design tool to protect the interests of all *Network Users* in terms of *reliability* and *quality of supply*. The criteria are also applied to protect all *network*s against instability.

13.8 *Network* development

The *Network Operator* is required to ensure that non-*network* alternatives to the reinforcement of the *network* are considered on an equivalent basis to *network* reinforcement and adopted where they can economically meet the *network* performance standards in clause 2 of the *Network Technical Code* and the *supply* contingency criteria in clause 14 of the *Network Planning Criteria*.

Non-*network* alternatives may include, without limitation, the following programs and technologies:

- Pricing signals to influence customer *demand*;
- Direct control of customer *demand*;
- Installation of *power factor* correction;
- Installation of embedded *generation*.

Non-*network* alternatives may involve agreements between the *Network Operator* and third parties for the provision of support to the *network* in specified contingency conditions.

13.8.1 Annual planning review

The *Network Operator* shall annually:

(a) Prepare a forecast of loads and *generation* for the system for a period of at least 5 years.

(b) Conduct a planning review of the adequacy of existing *connection point*s and the capacity of the *transmission* and *distribution network*s to meet forecast *load demand*s and *generation demands*.

(c) Consider the potential for augmentations, or non-*network* alternatives to augmentations, that are likely to provide economic benefit to all *Network Users*.

(d) Identify where *network investment*s are likely to be required and classify those investments as:

(1) a *small network investment*; or

(2) a *large network investment*.

(e) Prepare a *Network Management Plan* containing, amongst other things, *network* limitations and potential non-*network* and *network* solutions for *small network investments* and *large network investment*s in a form suitable for public dissemination.

(f) The *Network Management Plan* shall be made available on Power and Water's web site and made available to the interested parties established in clause 13.8.2(a) or to any person, upon application.

13.8.2 Non-*network* alternatives to *network* augmentation

(a) The *Network Operator* shall establish and maintain a list of interested parties that may be prepared to provide non-*network* alternatives to augmentation of the *network*.

(b) The *Network Operator* shall carry out a screening test to determine whether *demand* management or other non-*network* alternatives are likely to be viable for each *network investment* identified in clause 13.8.1(d).

(c) Where *demand* management or other non-*network* alternatives are not likely to be viable for a *network investment* the *Network Operator* shall carry out analysis of the *network* reinforcement in accordance with clause 13.9.

(d) Where *demand* management or other non-*network* alternatives are likely to be viable for a *large network investment*, the *Network Operator* shall:

(1) publish a report detailing the circumstances of the large network investment and the outcome of the demand management screening test in clause 13.8.2(b);

(2) advise interested parties of the large network investment;

(3) seek expressions of interest in providing a non-*network* alternative.

(e) If no expression of interest in providing a non-network alternative to a large network investment has been received within 60 business days the *Network Operator* shall carry out analysis of the *network* reinforcement in accordance with clause 13.9.

(f) Where *demand* management or other non-*network* alternatives are likely to be viable for a *small network investment*, the *Network Operator* shall inform interested parties of the outcome of the screening test in clause 13.8.2(b) and request expressions of interest in providing a non-*network* alternative.

(g) If no expression of interest in providing a non-network alternative to a small network investment has been received within 30 business days the *Network Operator* shall carry out analysis of the *network* reinforcement in accordance with clause 13.9.

(h) The *Network Operator* shall carry out the analysis of non-*network* alternatives provided by interested parties under clauses 13.8.2(d) and 13.8.2(f) in accordance with clause 13.9.

13.9 Investment analysis and reporting

In determining the preferred option for a new *large network investment*, the *Network Operator* shall:

(a) Analyse the proposed *large network investment* using financial parameters consistent with the most recent *Network* regulatory determination.

(b) Analyse non-*network* alternatives and *network* reinforcement alternatives on the same basis.

(c) Determine on a present value basis the least-cost non-*network* or *network* reinforcement alternative that meets the requirements of the *network* performance standards in clause 2 of the Code and the *supply* contingency criteria in clause 14 of the *Network Planning Criteria*.

(d) Include in the investment analysis an estimate of system benefits where they are likely to be material to the outcome of the analysis, including, but not limited to:

(1) Electrical losses;

(2) Changes in the level of involuntary load curtailment;

(3) Fuel and *generation* costs;

(4) Ancillary services provided to the system (eg. voltage support, *spinning reserve* or C-FCAS as applicable in each regulated power system, black start).

(e) The level of analysis undertaken in relation to system benefits in clause 13.9(c) shall be proportionate to the size and scale of the proposed new *network* investment.

(f) Determine and assess any non-quantifiable economic benefits of alternative investment options.

(g) Determine the preferred non-*network* or *network* investment alternative.

(h) Prepare a report on the *network* investment analysis in clause 13.9(a) to (g).

14 *Supply* contingency criteria

(a) *Supply* contingency criteria relate to the ability of the *supply* system (*network* and ~~*Generation*~~*generation*) to be reconfigured after a fault, so that the *supply* to *customer*s is restored. The criteria apply to ~~*Generation*~~ *generation* used to support the *network* and to the *network interconnection*s to *Generator*s.

(b) The following definitions apply.

14.1 *Load* areas

(a) The *load* areas that have been identified for the purpose of the *supply* contingency criteria are set out in ~~Table 11~~Figure 12.

Figure~~Table~~ 12~~11~~ - Definition of *load* types

Load type	Definition
CBD	Any area within a city or town that is zoned as CBD in the Northern Territory Planning Scheme.
Urban	An area in which the majority of the land is zoned for residential and/or commercial and/or industrial use within a major centre in the Northern Territory and is not CBD.
Non-urban	Areas that are not Urban and not within a CBD but which are within a 50km radius of a CBD.
Remote	Areas outside a 50km radius from a CBD.

(b) A distinction has been made between the *supply* contingency criteria applicable to CBD and Urban *load* areas, and those applicable to Non-urban and Remote *load* areas.

(c) A *supply* contingency may involve the unplanned failure of an element of *network* equipment or the failure of a *Generator* used to support the *network* at a particular location.

14.2 *Supply* contingencies

(a) A single *supply* contingency (first contingency) may involve the unplanned failure of an element of *network* equipment (a cable, line or *transformer*), or the failure of a *Generator* used to support the *network* or *supply loads* at a particular location.

A second contingency provision has been included, which is similar to that in the CBD areas of most other Australian capital cities. Other CBDs currently are planned to provide second contingency capability at the sub*transmission* and zone *substation* level, as follows:

- **Brisbane:** in one hour;
- **Melbourne:** in 30 minutes; and
- **Sydney:** in one hour.

The longer *time* permitted for restoration of the Darwin CBD system recognises that manual switching of *load* on the CBD HV *network* would be necessary to restore capability.

(b) A second *supply* contingency involves the concurrent failure of two elements, which could comprise *network* equipment or *Generators*.

(c) In addition, at the discretion of the *Network Operator*, certain high impact but low risk failures such as the failure of a single zone *substation* HV *busbar*, or the failure of a both circuits of a double circuit line, shall be considered as second *contingency events*.

14.3 Equipment capacities

Circuit capacities to be used in determining *supply* adequacy are the appropriate cyclic ratings for *network* equipment.

14.4 Forecast *demand*

(a) The forecast area *demand* used for determining *supply* adequacy is the coincident maximum *demand* for the *load* area, feeder or *transformer* concerned, with a 50% Probability of Exceedence.

(b) In calculating the maximum *demand* in clause 14.4(a), allowance shall be made for the coincident effect of *demand* reductions in the *load* area arising from:

(1) Any *demand* management initiative controlled by *Power and Water*;

(2) Any *customer* contracted to *Power and Water* to reduce *demand* upon request;

(3) The net effect of any embedded *Generation* used to provide a *demand* reduction under an agreement with *Power and Water*; and

(4) Small scale embedded *Generation* such as solar PV installations.

14.5 Radial *supply* arrangements

(a) Where restoration of *supply* requires reinstatement or repair, a secure *supply* having an alternative path is not provided. Restoration targets are set out in ~~Table 12~~Figure 13.

Figure~~Table~~ 13~~12~~ – Radial *supply* restoration targets

Radial *supply* contingency	Restoration target
For failure of a *substation transformer*	≤ 36 hours
For failure of a sub*transmission line*	≤ 6 hours (*loads* greater than 5MVA)
For failure of a sub*transmission line*	≤ 12 hours (*loads* less than 5MVA)

(b) The restoration times in Figure 13~~Table 12~~ are *Power and Water's* internal targets. They do not represent *customer* guarantees.

(c) Actual restoration times will be based on ensuring staff safety and being able to access and address the asset related issues.

14.6 *Supply* contingency criteria

The *supply* contingency criteria in the *Network Planning Criteria* have been designed to facilitate the ~~*Network Operator*~~*Network Operator* providing the specified response in the most appropriate and economical manner for the particular circumstances. The response to ensuring that the *supply* contingency criteria are met may include one or more of the following responses:

- Augmentation of the *network*;
- Reduction of *demand* on the *network* using demand management;
- Connection of *generation* within the load area concerned;
- Commercial arrangements with *generators* to provide *demand* support in contingency conditions;
- Enhanced operational response;
- Enhanced control of *network* configuration;
- Contingency planning, using strategically positioned spare equipment or mobile equipment such as *generators* and transformers.

(a) The *supply* contingency criteria in this clause 14.6 apply to loads and to groups of loads supplied by the *network* at various voltage levels and locations.

(b) In determining the relevant supply contingencies to loads and groups of loads, the potential unavailability of:

(1) elements of the *network* that normally supply those loads;

(2) the *generators* that normally supply those loads; and

(3) the associated *Generator connections*;

shall all be considered.

(c) The relative likelihood (frequency) of *supply* contingencies shall also be considered by the *Network Operator*. The *Supply Contingency Criteria* requires that:

(1) The *equipment* that comprises elements of the system for the supply to loads and groups of loads shall be operated and maintained in such a way that the frequency of equipment unavailability is consistent with good industry practice; and

(2) The expected frequency of *supply* contingencies shall be considered by the *Network Operator* when developing options to maintain compliance with the *Supply Contingency Criteria.*

(d) The *Network Operator* shall aim to meet reliability of *supply* objectives established by the *Regulator*.

(e) Where the availability of *generation* is a factor in meeting the contingency criteria in a particular load area the *Network Operator* is required to consult with the relevant *Generators* to make appropriate allowance for ~~*Generation*~~ *generating unit* ~~*Unit*~~ maintenance.

(f) The *Network Operator* may enter into commercial arrangements with a *Generator* to provide *demand* support in *supply* contingency conditions.

(g) The *Planning Criteria* in Figure 14~~Table 13~~ apply for the specified *supply* contingencies in CBD and Urban areas.

(h) The *Planning Criteria* in Figure 15~~Table 14~~ apply for Non-Urban and Remote areas.

(i) The *Planning Criteria* in Figure 14~~Table 13~~ and Figure 15~~Table 14~~ apply to each load segment within the loads or groups of loads to which the associated *Planning Criterion* applies.

Figure~~Table~~ 14~~13~~ - *Supply* contingency criteria - CBD and Urban areas

Class of *supply*	Forecast area *demand*	Minimum *demand* to be met after: First *supply* contingency	Minimum *demand* to be met after: Second *supply* contingency	Notes
A	Up to 1MVA	Within 8 hours: area *demand*	No special provision	Area *demand* is normally supplied from one source. Restoration of *supply* requires reinstatement or repair. Includes most HV *customer connections* and *distribution substations*. Where a single *transformer* supplies *demand*, the area *demand* may cover the *transformer* cyclic capacity.
B	Over 1 MVA and up to 5 MVA	(a) Within 3 hours: area *demand* less 1 MVA (b) Within 8 hours: area *demand*		Area *demand* is normally supplied from one source and may have partial to full *supply* available from an alternative source. Includes most HV feeders, allows for manual field switching.
C	Over 5 MVA and up to 50 MVA	(a) Within 60 minutes: area *demand*		Area *demand* is normally supplied from one or more source and will have partial to full *supply* from an alternative source. Will include many HV feeders and all zone *substations*. Area *demand* will be restored with automatic or manual switching of alternative sources of *supply*.
D	Over 50 MVA	(a) Immediate restoration of area *demand*	(b) Within *time* to restore planned *outage*: area *demand* (c) Within 5 hours: area *demand*	Area *demand* will normally be supplied by more than two alternative circuits with high level automatic and supervisory switching. The *time* permitted for restoration of *supply* to the Darwin CBD following a second contingency recognises that manual switching of *load* on the CBD HV *network* would be necessary. The second contingency provision is not intended to restrict the period during which maintenance can be scheduled. The provision for a second circuit *outage* assumes that normal maintenance would be undertaken when *demand* is less than peak.

Figure~~Table~~ 15~~14~~ - *Supply* contingency criteria - Non-Urban and Remote areas

Class of *supply*	Forecast area *demand*	Minimum *demand* to be met after: First *supply* contingency	Minimum *demand* to be met after: Second *supply* contingency	Notes
E	Up to 1MVA	Within 12 hours: area *demand*	No special provision	Area *demand* is normally supplied from one source. Restoration of *supply* requires reinstatement or repair. Includes most rural spur *connections*, HV *customer connections* and *distribution substations*. Where a single *transformer* supplies *demand*, the area *demand* may cover the *transformer* cyclic capacity.
F	Over 1 MVA and up to 5 MVA	(a) Within 6 hours: area *demand* less 1 MVA (b) Within 12 hours: area *demand*		Area *demand* is normally supplied from one source and will have partial to full *supply* available from an alternative source. Full restoration of *supply* may require reinstatement or repair. Includes most HV feeders, allows for manual field switching.
G	Over 5 MVA and up to 15 MVA	(a) Within 3 hours: area *demand* (b) Within 36 hours: area *demand*		Area *demand* is normally supplied from more than one source and will have full *supply* from an alternative source. Includes many zone *substations*. Area *demand* will be restored with manual switching of alternative sources of *supply*. Where area *demand* supplied from a single source (b) will apply.
H	Over 15 MVA and up to 50 MVA	(a) Within 30 minutes: area *demand* (b) Within 36 hours: area *demand*		Area *demand* is normally supplied from more than one source and will have full *supply* from an alternative source. Will cover larger zone *substations*. Area *demand* will be restored with automatic or remote manual switching of alternative sources of *supply*. Where area *demand* supplied from a single source (b) will apply.

15 Steady state criteria

(a) The steady state criteria define the adequacy of the *network* to *supply* the *energy* requirements of *Users* within the equipment ratings, *frequency* and *voltage* limits, taking account of planned and unplanned *outage*s.

(b) The steady state criteria apply to the normal continuous behaviour of a *network* and also cover post disturbance behaviour once the *network* has settled.

(c) In planning a *network* it is necessary to assess the *reactive power* requirements under both extremes of light and heavy *load*, to ensure that the reactive *demand* placed on the *Generator*s, be it to absorb or generate *reactive power*, does not exceed the capability of the *Generator*s and that system *voltage* levels remain within equipment ratings.

(d) *Network frequency* will fall if there is insufficient total *generation* to meet *demand*. Although the reduction in *frequency* will cause a reduction in power *demand*, it is unlikely that this will be sufficient and in the event of a shortfall of *generation*, *load*s shall be *disconnect*ed until the *frequency* rises to an acceptable level.

(e) In the following sub-clauses, the various components of the steady state *Planning Criteria* are defined.

15.1 Real and reactive generating limits

(a) Limits to the VAr ~~*Generation*~~ *generation* and absorption capability of *Generator*s shall not be exceeded.

(b) *Generator*s shall be specified and maintained so as to be capable of operating within the normal range of system *voltage* at their point of *connection*.

15.2 Steady state power *frequency voltage*

The range of steady-state *voltage* at different *voltage* levels of the *power system* under normal operating conditions is set out in this clause.

The *Australian Standard* for *low voltage* was altered in 2000. *Australian Standard* AS 60038-2000 establishes a revised nominal *voltage* of 230/400 V (single/three phase), to match the European standard set out in IEC 60038:1983.

Australian Standard AS 6038-2000 notes that 240/415 V systems shall evolve towards the new standard and a revised *supply voltage* range. *Power and Water* is participating in an Energy Networks Association review of issues associated with the potential migration from a nominal mid- range *voltage* of 240 V to 230 V.

(a) For *voltage*s of 11 kV or more, the *network* shall be planned and designed to maintain a continuous *network voltage* at a *User's connection* not exceeding the design limit of 110% of nominal *voltage* and not falling below 90% of nominal *voltage* during normal and maintenance conditions.

(b) The *network* shall be designed to maintain the *low voltage* steady state levels within the range set out in Figure 16~~Table 15~~ for *credible contingency events*. These are referenced to the nominal *voltage* of 230/400 V.

Figure~~Table~~ 16~~15~~ – *Supply voltage* range

System condition	Lower range	Upper range
Normal conditions	- 2%	+ 11%
Planned maintenance conditions	- 4%	+ 13%
Unplanned *outage* conditions	- 6%	+ 15%

(c) The power *frequency voltage* may vary outside the ranges set out in this clause 15.2 as a result of a *non-credible contingency event*.

15.3 Thermal rating criteria

(a) It should be noted that the thermal rating limits of equipment might not determine the capability of the *network* in a particular situation. Other factors such as the *voltage* drop or rise, *voltage* stability or system stability may impose a lower limit in certain circumstances.

(b) The thermal ratings of *network* components shall not be exceeded under normal or emergency operating conditions when calculated on the following basis:

(1) ***Transformers*:** Manufacturer's name plate rating, unless specific modelling has been carried out to determine a cyclic rating for the anticipated cyclic *load*ing and ambient temperature conditions.

(2) **Switchgear:** Manufacturer's name plate rating.

(3) **Overhead Lines:** Rating calculated in accordance with ESAA Code D(b)5, and based on:

(i) ambient temperature of 35°C in the northern part of the Territory, and 40°C (summer) or 25°C (winter) in the southern part;

(ii) wind speed being 0.5 m/s;

(iii) solar radiation being 1000W/m^2 (weathered surface); and

(iv) conductor design clearance temperature as defined in ESAA Code C(b)l.

(4) **Cables:** Normal cyclic rating, calculated using the Neher McGrath methodology; with

(i) maximum operating temperatures of 90°C for XLPE cables;

(ii) 70°C for 11 kV paper insulated cable;

(iii) 65°C for 11 kV paper insulated, belted cable and 22 kV paper insulated cables and;

(iv) during an emergency, for a period of up to 12 hours, the maximum allowable operating temperature for paper insulated cables may be increased to 80°C and for XLPE insulated cables to 120°C.

It should be noted that the thermal rating limits of equipment might not determine the capability of the *network* in a particular situation. Other factors such as the *voltage* drop or rise, *voltage* stability or system stability may impose a lower limit in certain circumstances.

15.4 Fault rating criteria

For safety reasons, the fault rating of any equipment shall not be less than the fault level in that part of the *network* at any time and for any normal *network* configuration.

As the system configuration is changed, fault levels may increase over time. New connections to the *network* shall therefore be designed with equipment fault level ratings reflecting modern standards that may exceed existing fault levels.

(a) The minimum fault levels for equipment to be connected to *Power and Water's network*s are set out in Figure 17~~Table 16~~.

Figure~~Table~~ 17~~16~~ – *Network* equipment fault level ratings

***Network voltage* level**	**Fault level rupturing capacity**
415 V	31.5 kA where supplied from one *transformer*; or 63 kA where supplied from two *transformer*s in parallel
11 kV	25 kA in metropolitan areas; 20 kA in rural areas
22 kV	15 kA
66 kV	31 kA
132 kV	31 kA

(b) Equipment owned by *Power and Water* and Users *connect*ed to the *network* shall be designed to withstand these fault levels for 1 second.

16 Stability criteria

(a) A *power system* is stable if it returns to a steady-state or equilibrium operating condition following a disturbance. This criterion shall hold true for all *load*ing conditions and ~~*Generation*~~ *generation* schedules, under normal operating conditions, following the loss of any item of *plant*, and for the most severe credible faults.

(b) In the planning and operation of a *power system*, it is important to consider the potential emergence of a variety of stability problems.

(c) The *Network Planning Criteria* are designed to ensure that the *network* has a high probability of returning to stable conditions, following all credible *network* disturbances.

(d) The stability of a *power system* can be classified into a number of categories to facilitate the analysis of stability problems, the identification of contributing factors, and the development of measures to control or prevent instability. Instability can take many different forms and is influenced by a wide range of factors.

(e) Two broad categories of stability are considered:

(1) Angle stability, which mainly involves the dynamics of *Generator*s and their associated *control system*s. Angle stability can be further categorised into transient stability and small-signal or steady-state stability. *Frequency* stability is closely related to angle stability.

(2) *Voltage* stability, which mainly involves the dynamic characteristics of *load*s and *reactive power* compensation. *Voltage* collapse is perhaps the most widely recognised form of *voltage* instability.

16.1 Transient stability

Transient stability is the inherent ability of a *power system* to remain stable and maintain *network* synchronism when subjected to severe disturbances such as three-phase faults on power lines, loss of ~~*Generation*~~*generation*, loss of a large *load* or other failures. Such large disturbances need to be cleared in order to prevent *network* instability and physical damage to *plant*.

Transient stability is assessed on the basis of the first angular swing following a solid three phase fault or single phase-to-ground fault on one circuit at the most critical location that is cleared by the faster of the two *protection scheme*s with all intertrips assumed in service.

16.1.1 Transient stability criteria

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

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

(2) the transient *voltage* dip limit as specified in clause 16.2.6; and

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

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

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

(2) a single phase to earth fault cleared by *backup protection*;

(3) high speed single phase auto-reclosing and

(4) sudden *disconnection* of any *plant*, including a *generating unit*~~*Generation Unit*~~.

(c) If the rotor angles between one (or a group) of synchronous machines and the rest of the *generating units* ~~*Generation Units*~~ on the *network* reaches and/or exceeds 180°, a "pole slip" occurs. This results in loss of synchronism or synchronous instability.

16.1.2 Rotor angle swing

(a) In general, an initial *Generator* rotor angle swing which does not exceed 120° and with XT ≤ 1.0 p.u. is considered stable.

(b) A rotor angle swing exceeding 120° has only a small margin before pole slipping, and an initial rotor swing angle which is higher than 120° may result in a pole slip or repeated pole slipping which is considered unstable.

(c) The relative rotor angle concept of synchronous instability is based on the rotor angle between two synchronous machines. In the case of two or more ~~*Generation*~~ *generation* groups containing various *Generator*s a correlated effect on the *network*, like transient *voltage* dip limits, shall be used to prevent synchronous instability.

(d) Rotor angle swings in excess of 120° or transient *voltage* dips in excess of 25% can result in the following detrimental effects on the *network*:

(1) *Network voltage* collapse; and

(2) Motor *load* loss on under*voltage*.

(e) Such impacts on a *network* are not acceptable and enforceable limits need to be used to prevent them.

16.1.3 *Fault clearance time*

(a) One of the major factors affecting transient stability is the *fault clearance time*. The *critical fault clearance time* is the longest *time* that a fault can be allowed to remain on the *network* whilst maintaining *network* stability. *Protection* shall be installed to ensure that the *critical fault clearance times* are achieved.

(b) A three-phase fault or a single-phase to ground fault (whichever is the more severe criterion), cleared by the primary *protection*, is selected by *Power and Water* as the basis for establishing transient stability. These faults shall be cleared within the *critical fault clearance time*.

(c) Transient stability shall be maintained for faults cleared by the tripping of any *network* element or a *Generator* under the worst possible *network load* or ~~*Generation*~~ *generation* pattern.

(d) Any *plant* leading to *network* instability shall be separated from the healthy *network*.

16.1.4 Rotor angle swing and transient *voltage* dip

(a) Rotor angle swing is not a practical parameter to be in field measured, but a measurable impact on *Users* is the transient *voltage* dip (TVD) resulting from real power swings.

(b) Any *Generator connect*ed to the *distribution network* shall not cause the *Transmission voltage* to exceed the transient *voltage* dip criteria defined in the *Network Technical Code*.

16.1.5 Pole slip *protection*

(a) The function of pole slip *protection* is to remove an unstable *Generator* from the *network* and prevent the disturbance from causing problems with other *Users*. Pole slip *protection* only removes the pole-slipping *Generator* from the *network* after the machine has slipped at least one pole.

(b) Pole slip *protection* is to be installed on all *generating units* ~~*Generation Units*~~ where simulations show that pole slipping is likely following any credible *plant outage* or fault.

16.1.6 Small-signal stability

(a) A *power system* is small-signal stable for a particular steady-state operating condition if, following any small disturbance, it reaches an equilibrium condition which is identical or close to the pre-disturbance condition. Small disturbances include the continuously changing system *load*, OLTC operations, and minor switching operations.

(b) Small-signal instability may be oscillatory, where undamped rotor angle oscillations grow to dangerous magnitudes, or monotonic, where rotor angle differences increase in one *direction*. In either case *generating units* ~~*Generation Units*~~ can fall out of synchronism with each other and pole slipping can occur.

(c) Small-signal stability is assessed on the basis of the damping design criterion which states that *"*System damping is considered adequate if, at any credible operating point, after the most critical *single contingency*, simulations indicate that the halving *time* of the least damped electromechanical mode of oscillation is not more than 5 sec. (The 5 sec. halving *time* corresponds to a damping constant of 0.14 Nepers/sec.).*"*

(d) Statistical effects shall be taken into account when analysing test results.

16.1.7 Oscillation damping

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

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

16.1.8 *Power system stabiliser*s

(a) *Power system* simulation studies may indicate the possibility of insufficient damping on the system, and that the best solution to this problem would be the installation of *power system stabiliser*s. These are to be installed on those *generating units* ~~*Generation Units*~~ where they will be most effective in improving overall system damping.

(b) The stabilising circuits shall be responsive and adjustable over a wide range of *frequency* range, which shall include frequencies from 0.1 Hz to 2.5 Hz. The PSS settings shall be optimised to provide maximum damping.

16.2 *Voltage* stability criteria

16.2.1 *Voltage* stability limits

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

Notes:

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

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

(b) *Voltage* stability is a function of the dynamic characteristics of system *load*s. A *power system* at a given operating state and subject to a given disturbance is *voltage* stable if post-disturbance *voltage*s at every point on the system reach equilibrium within satisfactory limits. Disturbances may be small or large, and *time* frames may vary from tenths of a second to several hours.

(c) *Voltage* instability most commonly results in *voltage* collapse, but may give rise to excessively high *voltage* levels under some conditions.

(d) Adequate and appropriate *reactive power* compensation shall be provided to ensure that the *power system* is protected against all forms of *voltage* instability. This can include the use of shunt and series capacitors and / or *reactor*s, SVCs, *synchronous condensers*, etc.

16.2.2 *Voltage* collapse

(a) A *power system* undergoes *voltage* collapse if post-disturbance *voltage*s are below acceptable limits. *Voltage* collapse may be total (blackout) or partial.

(b) The possibility of an actual *voltage* collapse depends upon the nature of the *load*. If the *load* is stiff (constant power, such as a synchronous motor) the collapse is aggravated. If the *load* is soft, eg. heating, the power absorbed by the *load* falls off rapidly with *voltage* and the situation is alleviated.

16.2.3 Resonance conditions

(a) *Voltage* oscillations can arise within a *power system* as a result of resonance conditions. Resonance effects are generally caused by a series resonance between a capacitance and an inductance, for example a *capacitor bank* and the inductive reactance of a *transmission line* or *transformer*.

(b) *Network* resonant frequencies can exist above and below synchronous *frequency* and a latent resonance can be excited by a variety of *network* disturbances (large or small).

(c) If resonance is excited following a *network* disturbance, then oscillations appearing as *network voltage* amplitude modulations can arise.

(d) If the damping mode of the *network* at the resonant *frequency* is positive then the *network* will absorb the oscillation. However, if the damping is negative, the oscillations will build up and lead to supersynchronous (>50 Hz) or subsynchronous (<50 Hz) instability.

(e) If corrective action (typically in the form of *load shedding*) is not taken, then this form of oscillation can lead to extensive damage to *network* and *customer* equipment.

(f) Locations with a low fault level and a weak electrical *connection* (usually with impedance higher than 1.0 p.u. to the source) are prone to sub-synchronous oscillations or resonance.

16.2.4 Transient over-*voltage*s

Transient over-*voltage*s can arise from normal switching operations and external influences such as lightning strikes. Surge diverters are used where necessary to ensure that the transient over-*voltage* seen by an item of *network plant* is limited to its rated lightning impulse withstand *voltage* level.

16.2.5 Temporary over-*voltage*s

Temporary AC over-*voltage*s should not exceed the *time* duration limits given in *Australian Standard* AS2926 – 1987 unless specific designs are implemented to ensure the adequacy and integrity of equipment on the *power system*, and that the effects on *load*s have been adequately mitigated.

16.2.6 Transient *voltage* dip criteria (TVD)

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

16.3 *Frequency* stability criteria

(a) The *frequency* stability criterion relates to the recovery times for excursions of the system *frequency* from the steady state limits.

(b) The *rate of change of frequency* for each of the regulated power systems is defined as:

Darwin – Katherine	± 4 Hz/ Sec
Alice Springs	± 4 Hz/ Sec
Tennant Creek	± 4 Hz/ Sec

~~(a)~~(c) To cover for a loss of a *generating system*~~*Generation Facilities*~~ *facilities* there are two measures applied to bring back the falling *frequency*:

(1) *Spinning reserve*; and

(2) *Under frequency load shedding* (UFLS).

~~(b)~~(d) *Under frequency load shedding* relays are installed at zone *substations* to shed *load* at pre-determined levels of *frequency* at or below 49.25 Hz following loss of a major *generating unit* ~~*Generation Unit*~~ or its *interconnection*.

~~(c)~~(e) Following loss of a *generating system*~~*Generation Facilities*~~, system *frequency*, depending on *spinning reserve* or C-FCAS as applicable in each regulated power system, may still decline to such levels that the UFLS automatic scheme will be used to reduce *network load* in order to help the *frequency* recovery.

~~(d)~~(f) It is a requirement for *power system security* that 75% of the *power system load* at any *time* be available for *disconnection* under:

(1) The automatic control of *under frequency* relays; and

(2) Manual or automatic control from *control centre*s; and/or

(3) The automatic control of under*voltage* relays.

~~(e)~~(g) 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*. *Power and Water* will advise *Users* if this additional requirement is necessary.

~~(f)~~(h) Special *load shedding* arrangements may be required to be installed to cater for abnormal operating conditions.

~~(g)~~(i) The settings for *under-frequency load shedding* in the various *regions* throughout the Northern Territory are given in Figure 3 ~~Table 3~~ of *this Code*.

17 *Quality of supply* criteria

(a) *Quality of supply* criteria regulate the *voltage* and current waveforms in the *network* and criteria are established for the following aspects:

(1) *Voltage* fluctuation;

(2) System *Frequency*;

(3) Harmonic distortion;

(4) *Voltage* unbalance; and

(5) *Network reliability*.

(b) The *network*s are analysed to ensure satisfactory performance, in accordance with the *quality of supply* criteria, whenever a new *User* is *connect*ed or a complaint from an existing *User* is received.

(c) The aspects of *quality of supply* that are analysed are:

(1) *Steady state voltage;*

(2) *Voltage* fluctuation; and

(3) *Network frequency, on isolated regional networks.*

(d) Harmonic *voltage* and current and *voltage* unbalance will be analysed depending on the nature of the *load* of the new *User* being *connect*ed.

17.1 *Voltage* fluctuation criteria

A *voltage* disturbance is where the *voltage* shape is maintained but the *voltage* magnitude varies and may fall outside the steady state *supply voltage* range set out in clause 15.2 of the *Network Planning Criteria*.

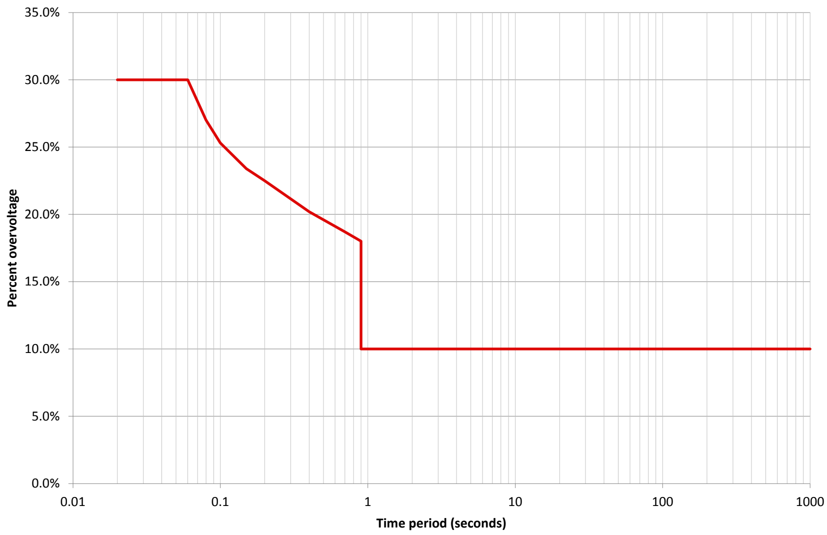
(a) Short duration *voltage* disturbances with durations of up to one minute are termed *voltage* sags and swells.

(b) Short duration *voltage* disturbances generally arise from faults on the *network* and may not be able to be economically eliminated.

17.1.1 Temporary over-*voltage*s

(a) As a consequence of a *credible contingency event*, the *voltage* of *supply* at a *connection point* should not rise above its normal *voltage* by more than a given percentage of normal *voltage* for longer than the corresponding period shown in Figure 18~~Figure 4~~ for that percentage.

Figure 18 – Over *voltage* limit for *contingency event*s



(b) *Users'* equipment shall also be designed to withstand these *voltage* levels.

(c) As a consequence of a *contingency event*, the *voltage* of *supply* at a *connection point* could fall to zero for any period.

17.1.2 Step *changes* in *voltage* levels

(a) Step changes in the *power system voltage* levels may take place due to switching operations on the *network*. The step *change*s in *voltage* shall not exceed the limits set out in Figure 19~~Table 17~~.

Figure~~Table~~ 19~~17~~ – Step *change voltage* limits

Cause	Pre-tap-changing		Post-tap-changing (final steady state)	
	≥ 66 kV	< 66 kV	≥ 66 kV	< 66 kV
Routine Switching (1)	±4.0 % (max)	±4.0% (max)	*Network voltages* shall be between 110% and 90% of nominal *voltage*	Should attain previous set point
Infrequent Switching (2)	+6%, –10% (max)	+6%, –10% (max)	±10% (max)	Should attain previous set point
Notes: 1 For example, capacitor switching, *transformer* tap action, motor starting, start-up and shutdown of *generating unit*~~Generation Units~~s. 2 For example, tripping of *generating unit*~~Generation Units~~s, *loads*, lines and other components.				

(b) *Voltage* fluctuation severity is characterised by the following two quantities, which are defined in *Australian Standard* AS/NZS 61000.3.7 (2001):

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

(2) P_{lt} - long-term flicker severity (obtained from 12 consecutive P_{st} periods for each 2 hour period).

(c) Under normal operating conditions, flicker severity caused by *voltage* fluctuation in the *transmission* and *network* shall be within the planning levels shown in Figure 20~~Table 18~~ for 99% of the *time*.

Figure~~Table~~ 20~~18~~ – Flicker severity – planning levels

Flicker Severity Quantity	LV 230/400 V	MV (11-66 kV)	HV (132 kV)
P_{st}	1.0	0.9	0.8
P_{lt}	0.7	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 are unity. The planning levels could be increased in accordance with AS61000.3.7 (2001).
2. The planning levels in this Table are not intended to apply to flicker arising from contingency and other uncontrollable events in the *power system*, etc.

(d) *Voltage* fluctuations for individual *Users* shall be measured at the point of Common Coupling, which is the point of *connection* to other *Users* in the same portion of the *network*.

17.2 Harmonic *voltage* and current distortion

(a) *Power and Water's* power *networks* and all *plant* and equipment *connected* thereto shall be planned and designed to ensure that harmonic *voltages* and currents do not exceed the limits defined in *Australian Standard* AS/NZS 61000.3.6 (2001).

(b) For planning purposes the harmonic *voltage* levels shown in Figure 21~~Table 19~~ apply to the respective system *voltage* level.

Figure~~Table~~ 21~~19~~ - Harmonic *voltage* distortion limits – planning levels

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* %**	
	LV	≥11 kV		*LV*	≥11 kV		*LV*	≥11 kV
5	5.0	2.0	3	4.0	2.0	2	1.6	1.5
7	4.0	2.0	9	1.2	1.0	4	1.0	1.0
11	3.1	1.5	15	0.3	0.3	6	0.5	0.5
13	2.5	1.5	21	0.2	0.2	8	0.4	0.4
17	1.6	1.0	>21	0.2	0.2	10	0.4	0.4
19	1.2	1.0				12	0.2	0.2
23	1.2	0.7				>12	0.2	0.2
25	1.2	0.7						
>25	$0.2 + 0.5 \cdot \frac{25}{h}$	$0.2 + 0.5 \cdot \frac{25}{h}$						

Notes to Figure 21~~Table 19~~:

1. This Table is derived from *Australian Standard* AS/NZS 61000.3.6 (2001).
2. The total harmonic distortion (U_t) is calculated from the expression

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

Where:

U_{nom} nominal *voltage* of a system

U_1 fundamental *voltage*

U_h harmonic *voltage* of order h expressed as a percentage of the nominal *voltage*.

3. The harmonic distortion limits apply to each phase.
4. Intermittent harmonic *voltage* distortion is subject to the same limits as continuous harmonic *voltage* distortion.

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

17.2.1.1 Inter-harmonic distortion

Inter-harmonic or non-integer harmonic distortion may arise from large convertors or power electronics equipment with Pulse Width Modulation (PWM) converters interfacing with the *power system*.

A *User's* inter-harmonic *voltage* distortion contribution shall not exceed the planning level of 0.2% specified in section 9 of *Australian Standard* AS/NZS 61000.3.6:2001.

17.2.2 Direct current

(a) *Plant* and equipment shall comply with the requirements on direct current components as stipulated in clause 3.12 of *Australian Standard* AS 3100. In particular, the direct current in the neutral caused by the *User's plant* and equipment shall not exceed 120mAh per *day*.

(b) The responsibility of the ~~*Network Operator*~~*Network Operator* for direct current in the neutral outside the limits specified in this clause shall be limited to direct current in the neutral caused by *network* assets.

(c) *Plant* and equipment at *Users'* premises shall perform to the standards specified in subclause (a).

17.3 *Voltage* unbalance

(a) For normal system operation and for planned system *outages*, the *voltage* unbalance at each of *connection points* to the *network* shall not exceed the limits set out in clause 2.4.3 of the *Code*.

(b) The responsibility of *Power and Water* for *voltage* unbalance outside the limits specified in clause 17.3(a) shall be limited to *voltage* unbalance caused by *network* assets.

(c) *Users'* equipment shall perform to the standards specified in clause 17.3(a).

17.4 Electromagnetic interference

Power and Water shall design its *networks* to ensure that the electromagnetic interference caused by its *plant* and equipment does not exceed the limits set out in Tables 1 and 2 of *Australian Standard* AS 2344.

18 Construction standards criteria

(a) *Power and Water* shall construct the overhead portions of its *networks* in accordance with the Electricity Supply Association of Australia publication C(b)1 -"Guidelines for Design and Maintenance of Overhead Distribution and Transmission lines".

(b) *Power and Water* shall construct the underground portions of its *network*s in accordance with the Electricity Supply Association of Australia publication C(b)2 - *"*Guide to the Installation of Cables Underground*"*.

18.1 Conductor selection criteria

(a) *Power and Water* generally uses overhead conductors for *transmission* and sub-*transmission* circuits in order to minimise construction costs. *Power and Water* may use underground cables for such circuits where required by environmental *constraint*s and where the additional cost can be justified.

(b) *Power and Water* uses underground cables for *distribution network* reinforcement and *extension* within the Darwin Metropolitan area, *Regional* Centres, new sub-divisions where in *Power and Water'*s opinion they are appropriate, or if required by legislation. Outside these areas *Power and Water* will generally install overhead conductors.

(c) In designing *extension*s to the *network*, ultimate *load* horizon planning shall be used to establish the *network* concept plan and the initial installation shall conform to that concept plan and use carriers that are appropriately sized. This methodology eliminates the need to disrupt the community in future years as *load* growth occurs and results in the minimum lifetime cost to the community.

(d) To achieve maximum cost efficiency in the installation of conductors, standard overhead conductor and underground cable sizes have been selected. This results in minimum stock holdings and purchase prices, giving the *User* the least cost *network*.

(e) The standard conductor size that is equal to, or greater than that required for the reasonably foreseeable *load*, shall be used for each overhead *network extension* or reinforcement.

(f) The standard cable size that is equal to, or greater than that required for the horizon *load*, shall be used for each underground *network extension* or reinforcement.

19 Environmental criteria

Power and Water's environmental policy states that:

"*Power and Water* recognises and accepts its environmental responsibilities arising from the provision of power, water and sewerage services.

"*Power and Water* will seek to minimise environmental impacts and comply with environmental regulations.

"Continual improvement in environmental performance will be sought by *Power and Water* through:

- Implementing a comprehensive Environmental Management System;
- Minimising the environmental impacts of its operations;

- Promoting individual ownership of environmental care among its people; and
- Consulting with the community on environmental issues.

"Sustainable Development will be pursued by *Power and Water* through:

- Adoption of integrated resource planning;
- Use of renewable resources;
- Maximisation of long term benefits from non-renewable resources; and
- Promotion and adoption of waste minimisation and recycling practices."

Power and Water commits to the following objectives to fulfil its environmental policy:

- To consult openly and fully with the community and government where Authority activity may affect the environment;
- To ensure that planning and design for new projects and *change*s to existing processes provide for consideration of best environmental practice technology and *time*ly impact assessment; and
- To carry out its business in a resource efficient manner.

Power and Water's power *network*s will be developed so that these *commitment*s are met.

19.1 Social issues

Power and Water shall inform and consult with relevant public bodies and community interest groups and the general public on the planning of new developments and facilities.

19.2 Electromagnetic fields

Recognising the current state of scientific uncertainty regarding adverse health effects from exposure to power *frequency* electric and magnetic fields, *Power and Water* shall act prudently and design, construct and operate all equipment and facilities to maintain electromagnetic field exposure to the public and *Power and Water* employees at levels within the Interim Guidelines on Limits of Exposure to 50/60 Hz Electric and Magnetic Fields set out in the ARPANSA Radiation Health Series No. 30 standard.

19.3 Land-Use considerations

Power and Water shall avoid, or minimise damage to natural, cultural and historical sites where reasonable and economically practical, consistent with the safe and *reliable* operation of the electricity *supply network*.

19.4 Noise

Power and Water shall comply with the noise limit provisions of relevant guidelines made under the *Waste Management and Pollution Control Act*.~~the *Environmental Protection Act*~~.

19.5 Visual amenity

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

Part D Attachments

Attachment 1 Glossary of Terms

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

(a) A word or phrase set out in column 1 of the table below has the meaning set out opposite that word or phrase in column 2 of the table below; ~~and~~

(b) A word or phrase defined in the *Power and Water Corporation Act* has the meaning given in that Act unless redefined in the table below; and

~~(b)~~(c) An italicised word or phrase defined in the *NT NER* has the meaning given in the *NT NER* unless redefined in the table below.

Terminology	Definition
~~***Access Agreement***~~	~~Means a contract or agreement for the provision of *network access services* entered into between a *network* provider and a *network User* under the *Code*, and includes an award made by an arbitrator for the same purpose.~~
~~***Access Applicant***~~	~~An existing or new *network User*~~*Network User* ~~making an *Access Application* under clause 10 of the Electricity Networks (Third Party Access) Code.~~
Access Application	An "access application" made under clause 10 of the Networks Access Code or a connection application or application to connect made under Chapter 5 or Chapter 5A of the NT NER.~~*Access Application* made under clause 10 of the Electricity Networks (Third Party Access) Code, which is described in Attachment 6.~~
access services	The following services: *use of system services*; *common services*; *connection services* and *ancillary services*.
active energy	A measure of electrical *energy* flow, being the *time* integral of the product of *voltage* and the in-phase component of current flow across a *connection point*, expressed in Watt-hours (Wh) and multiples thereof.
active power	The rate at which *active energy* is transferred.
active power capability	The maximum rate at which *active energy* may be transferred from a *generating unit* ~~*Generation Unit*~~ to a *connection point* as specified in an *Access Agreement*.
active unit protection	Generally, a *protection scheme* that compares the conditions at defined *primary plant* boundaries and can positively identify whether a fault is internal or external to the protected *plant*. Unit *protection schemes* can provide high speed (less than 150 milliseconds) *protection* for the protected *primary plant*. Generally, unit *protection schemes* will not be capable of providing back up *protection*.
agreed capability	In relation to a *connection point*, the capability to receive or send out *active power* and *reactive power* for that *connection point* determined in accordance with the relevant *Access Agreement*.
ancillary services	The following services: *voltage control*, *reactive power* control,

Terminology	Definition
	frequency control, *control system services*, *spinning reserve* and *post-trip management*.
ancillary services agreement	An agreement covering the provision of *ancillary services*.
associated load	A *load* which is normally supplied by a particular *Generator* and is associated with that *Generator* by ownership or some contractual arrangement. The *load* may be remote from the *Generator* or on-site.
augment, augmentation	In relation to the *electricity network*, means to enlarge or expand the capability of the *electricity network* to accept, transport and deliver electricity.
***Australian Standard* (AS)**	The most recent edition of a standard publication by Standards Australia (Standards Association of Australia).
automatic access standard	In relation to a technical requirement of access, a standard of performance, identified in clause 3.3.5 of this *Code* as an automatic access standard for that technical requirement, such that a *plant* that meets that standard would not be denied access because of that technical requirement.
automatic reclose equipment	In relation to a power line, the equipment which automatically recloses the relevant line*'*s circuit breaker(s) following their opening as a result of the detection of a fault in the power line.
backup protection	A *protection* intended to supplement the main *protection* in case the latter should be ineffective, or to deal with faults in those parts of the *power system* that are not readily included in the operating zone of the main *protection*.
black start capability	In relation to a *generating unit*~~*Generation Unit*~~, the ability to start and *synchronise* without using *supply* from the *power system*.
black start-up facilities	The facilities required to provide a *generating unit* ~~*Generation Unit*~~ with black start-up capability.
black system	The absence of *voltage* on all or a significant part of the *network* following a major *supply* disruption, affecting one or more *power stations* and a significant number of *customer*s.
breaker fail protection	In relation to a *protection scheme*, that part of the *protection scheme* that protects a *User's* facilities against the non-operation of a circuit breaker when it is required to open.
busbar	A common *connection point* in a *power station substation* or a *transmission network substation*.
business day	Any *day* other than a Satur*day*, Sun*day*, or *day* that is a public holi*day* in the City of Darwin.
capacitor bank, capacitor	A type of static electrical equipment used to generate *reactive power* and therefore support *voltage* levels on *network* elements.
cascading outage	The occurrence of an uncontrollable succession of *outage*s, each of which is initiated by conditions (eg. instability or over*load*ing) arising or made worse as a result of the event preceding it.
C-FCAS	Contingency frequency control ancillary services (a subset of FCAS).
change	Includes amendment, alteration, addition or deletion.

Terminology	Definition
~~***check metering installation***~~	~~A *metering* installation which may be used as a source of *metering* data for validation, substitution or account estimation as provided in clause 10 of this *Code*.~~
circuit breaker failure	A circuit breaker will be deemed to have failed if, having received a trip signal from a *protection scheme*, it fails to interrupt fault current within its design operating *time*.
Code, Technical Code	This *Code* called the *Technical Code*.
Code commencement date	The date given in clause 1.4 of this *Code*.
commitment	The commencement of the process of starting up and *synchronising* a *generating unit* ~~*Generation Unit*~~ to the *power system*.
common services	A *network* service that ensures the integrity of the *electricity network* and benefits all *Users* and that cannot be practically ~~be~~ allocated to *Users* on a locational basis.
complementary	In relation to *protection*, two *protection schemes* are said to be *complementary* when, in combination, they provide dependable clearance of faults on *plant* within a specified *time*, but with any single failure to operate of the *secondary plant*, fault clearance may be delayed until the nature of the fault *changes*.
connect, connection	Means to establish an effective link via installation of the necessary *connection* equipment.
connection agreement	Means an agreement between a network provider and a *Network User* which permits a person to *connect* plant or premises to the *network*. It includes an agreement for the provision of *network access services* entered into *network* provider whether under the former Network Access Code, or under applicable provisions of the *NT NER.*
connection asset	Means all of the electrical equipment that is used only in order to transfer electricity to or from the *electricity network* at the relevant *connection point* and includes any *transformers* or switchgear at the relevant point or which is installed to support or to provide backup to such electrical equipment as are necessary for that transfer.
connection point	A point at which electricity is transferred to or from an *electricity network*.
connection services	In relation to a *connection point*, means the establishment and maintenance of that *connection point*.
constraint, constrained	A limitation on the capability of a *network*, *load* or a *generating unit* ~~*Generation Unit*~~ preventing it from either transferring, consuming or generating the level of electrical power which would otherwise be available if the limitation was removed.
~~***contingency capacity reserve***~~	~~Actual active and *reactive energy* capacity, *interruptible load* arrangements and other arrangements organised to be available to be utilised on the actual occurrence of one or more *contingency events* to allow the restoration and maintenance of *power system security*.~~
contingency frequency	Services to correct the generation / demand balance following a

Terminology	Definition
control ancillary services	major contingency event such as the loss of a *generating unit*, major industrial load, or a large transmission element.
contingency event	An event affecting the *power system* which the *Network Operator* expects would be likely to involve the failure or removal from operational service of a *generating unit* ~~*Generation Unit*~~ or *network* element.
control centre	The *facility* used by the *Power System Controller* for directing the minute to minute operation of the *power system*.
controller	A person employed by a *Power System Controller* engaged in the activities of controlling the transfer of electrical *energy* at a *connection point*.
control system	Means of monitoring and controlling the operation of the *power system* or equipment including *generating units* ~~*Generation Units*~~ *connected* to a *network*.
control system services	The 24-hour control of the *power system* through monitoring, switching and *dispatch* which is provided through *control centres* and SCADA and communication equipment.
credible contingency event	A *contingency event* the occurrence of which the *Network Operator* considers to be reasonably possible in the surrounding circumstances.
critical fault clearance time	Refers to the maximum *total fault clearance time* that the *power system* can withstand without one or both of the following conditions arising: • Instability (refer to clause 2.6); and • Unacceptable disturbance of *power system voltage* or *frequency*.
critical single credible contingency event	A single *credible contingency event* considered by the *Network Operator,* in particular circumstances, to have the potential for the most significant impact on the *power system* at that *time*. This would generally be the instantaneous loss of the largest *generating unit* ~~*Generation Unit*~~ or a fault on a *network* element on the *power system*. However, this may involve the consideration by the *Network Operator* of the impact of the loss of any *interconnection* under abnormal conditions.
credible contingency	An individual *credible contingency event* for which a *User* adversely affected by the event would reasonably expect, under normal conditions, the design or operation of the relevant part of the meshed *power system* would adequately cater, so as to avoid significant disruption to *power system security*.
current rating	The maximum current that may be permitted to flow (under defined conditions) through a power line or other item of equipment that forms part of a *power system*.
current transformer (CT)	A *transformer* for use with meters and/or *protection* devices in which the current in the secondary winding is, within prescribed error limits, proportional to and in phase with the current in the primary winding.

Terminology	Definition
customer	A person who purchases electricity supplied through a *network*.
day	Unless otherwise specified, the 24 hour period beginning and ending at midnight Australian Central Standard *Time*.
decommission, decommissioning	In respect of an item of *plant* or a *generating unit*~~*Generation Unit*~~, ceasing to operate and being *disconnected* from a *network*.
derogation	Modification, variation or exemption to one or more provisions of the *Code* in relation to a *User* according to clause 12.
de-synchronising/ de-synchronisation	The act of *disconnection* of a *generating unit* ~~*Generation Unit*~~ from the *power system*, normally under controlled circumstances.
differing principle	Two *protection schemes* are said to be of *differing principle* when their functioning is based on different measurement or operating methods, or use similar principles but have been designed and manufactured by different organisations.
direction	A *direction* issued by the *Network Operator* or *Power System Controller* to any *User* requiring the *User* to do any act or thing which the *Network Operator* or *Power System Controller* considers necessary to maintain or re-establish *power system security* or to maintain or re- establish the *power system* in a *reliable* operating state in accordance with this *Code*.
disconnection, disconnect, disconnected, disconnecting	In respect of a *connection point* or item of *plant*, means to operate switching equipment so as to prevent the transfer of electricity through the *connection point* or item of *plant*.
dispatch	The act of committing to service all or part of the *generation* available from a *scheduled* *generating unit*.
distribution system, distribution network	That part or those parts of the *electricity network* used for transporting electricity at nominal *voltages* of less than 66 kV and at a nominal *frequency* of 50Hz.
dynamic performance	The response and behaviour of *networks* and facilities which are *connected* to the *networks* when the normal operating state of the *power system* is disturbed.
electrical energy loss	*Energy* loss incurred in the production, transportation and/or use of electricity.
electricity network	The *connection assets* and *network* system assets which together are operated by the network provider for the purposes of transporting electricity from *Generators* of electricity to a transfer point or to consumers of electricity.
Electricity Reform Act	The *Electricity Reform Act 2000* (NT)
Electricity Reform (Administration) Regulations	*Electricity Reform (Administration) Regulations 2000* (NT)
electricity transmission capacity	The capacity of the *transmission network* to transmit power between two or more points under the full range of operating conditions likely to be experienced in service.
embedded Generator	A *Generator* which supplies on-site *loads* or *distribution network loads* and is *connected* either indirectly (ie. via the *distribution network*) or directly to the *transmission network*.

Terminology	Definition
energise/energisation	The act of operation of switching equipment or the start-up of a *generating unit*, which results in there being a non-zero *voltage* beyond a *connection point* or part of the *network*.
energy	*Active energy* and/or *reactive energy*.
~~***energy data***~~	~~The data that results from the measurement of the flow of electricity in a power conductor. The measurement is carried out at a *metering* point.~~
excitation control system	In relation to a *generating unit*, the automatic *control system* that provides the field excitation for the *Generator* of a *generating unit* (including excitation limiting devices and any *power system stabiliser*).
Existing Connection Plant	Has the meaning given in clause 12.2.
extension	The capital investment associated with the designing, constructing, installing and commissioning of the *electricity network* assets required to *connect* a *User* to the *electricity network*.

Terminology	Definition
facility	A generic term associated with the apparatus, equipment, buildings and necessary associated supporting resources provided at, typically: • a *power station* or *generating unit*, including start-up facilities; • a *substation* or *power station substation*; • a *control centre*.
fault clearance time	The *time* interval between the occurrence of a fault and the fault clearance.
FCAS	*Frequency control ancillary services*
financial year	A period commencing on 1 September 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 control ancillary services	The suite of services used by the *Power System Controller* to maintain the frequency on the electrical system, at any point in time, close to fifty cycles per second as required by the NT frequency standards.
frequency operating standards	The *frequency* standards set out in clauses 2.2, and 2.4 of this *Code*.
frequency response mode	The mode of operation of a *generating unit* which allows automatic *changes* to the *generated* power when the *frequency* of the *power system changes*.
generated	In relation to a *generating unit*, the amount of electrical *energy* produced by the *generating unit* as measured at its terminals.
g~~G~~enerating s~~S~~ystem	A ~~A system comprising one or more *Generation Units*.~~system comprising one or more *generating units* and that includes auxiliary or *reactive plant* that is located on the *Generator's* side of the

Terminology	Definition
	connection point and is necessary for the *generating system* to meet its *performance standards*.
~~***Generator, Generation Unit/Facilities***~~	~~An electricity generator, and all related equipment essential to the generator's operation, which supplies electricity into an electricity network and together function as a single entity.~~
generating unit	The plant used in the production of electricity and all related equipment essential to its functioning as a single entity.
~~G~~generation	The production of electrical *energy* by converting another form of *energy* in a *generating unit*~~*Generation Unit*~~.
generation centre	A geographically concentrated area containing a *generating unit*~~*Generation Unit*~~ or *generating units*~~*Generation Units*~~ with significant combined generating capability.
Generator	A person who engages in the activity of owning, controlling or operating a *generating system* that is *connected* to a *Network* and, in respect of a *generating system* connected to the Darwin-Katherine power system, is either registered by the *Market Operator* as a *Generator* or, intends to register with the *Market Operator* as a *Generator*.
Generator User	A person who has been granted access to the electricity network by the network provider and who supplies electricity into the electricity network at an entry point.
good electricity industry practice	The exercise of that degree of skill, diligence, prudence and foresight that reasonably would be expected from a significant proportion of operators of facilities forming part of a *power system* for the ~~*Generation*~~*generation*, *transmission distribution* and *supply* of electricity comparable to those applicable to the relevant *facility* consistent with applicable laws, the Access *Code*, the *Technical Code*, licences, industry *Code*s, *reliability*, safety and environmental *protection*.
governor system	The automatic *control system* which regulates the speed and power output of a *generating unit* ~~*Generation Unit*~~ through the control of the rate of entry into the *generating unit* ~~*Generation Unit*~~ of the primary *energy* input (for example, steam, gas or water).
inertia	Contribution to the capability of the power system to resist changes in frequency by means of an inertial response from a *generating unit*, network element or other equipment that is electro-magnetically coupled with the power system and synchronised to the frequency of the power system.
inertia FCAS	Inertia frequency control ancillary services (a subset of FCAS).
Inertia frequency control ancillary services	Services that contribute to the capability of the power system to resist changes in frequency by means of an inertial response from a *generating unit*, network element or other equipment that is electro-magnetically coupled with the power system and synchronised to the frequency of the power system.
instrument transformer	Either a *current transformer* (CT) or a *voltage transformer* (*VT*).
interconnection,	A *transmission line* or group of *transmission line*s that *connect*s the

Terminology	Definition
interconnector, interconnect, interconnected	*transmission network*s in adjacent *regions*.
interruptible load	A *load* which is able to be *disconnect*ed, either manually or automatically initiated, which is provided for the restoration or control of the *power system frequency* by the *Power System Controller* to cater for *contingency event*s or shortages of *supply*
intra-regional	Within a *region*.
Large Generator	A *Generator* that is not a *Small Generator.*
large network investment	A proposed investment in augmentation of the *network* or a non-*network* alternative with a capitalised net present value in excess of $5 Million.
load, loading	The amount of electrical *energy* delivered at a defined instant at a *connection point* or aggregated over a group of *connection point*s.
load centre	A geographically concentrated area containing *load* or *load*s with a significant combined consumption capability.
load shedding	Reducing or *disconnect*ing *load* from the *power system*. (See also *under frequency load shedding*, *under voltage load shedding*).
local black system procedures	The procedures, described under clause 4.7.9 applicable to a *User* as procedures approved by the *Power System Controller* from *time* to *time*.
low voltage **(*LV*)**	That portion of the *network* and *connection*s to it operating at a nominal *voltage* of 230 volts single phase or 400 volts three phase.
Market Operator	A function of the *Power System Controller* pursuant to the *Electricity Reform Act* and *Electricity Reform (Administration) Regulations*.
maximum fault current	The current that will flow to a fault on an item of *plant* when *maximum system conditions* prevail.
maximum system conditions	For any particular location in the *power system*, *maximum system conditions* are those which will prevail with the maximum number of *Generator*s and *network* elements normally *connect*ed at *time*s of maximum ~~*Generation*~~*generation*.
meter, metering, metering equipment	Equipment used to measure and record the rate at which electricity is transferred and the quantity of electricity transferred to and from the *network*.
minimum fault current	The current that will flow to a fault on an item of *plant* when present *day minimum system conditions* prevail.
minimum system conditions	For any particular location in the *power system*, *minimum system conditions* are those which will prevail with the least number of *Generator*s and *network* elements normally *connect*ed at *time*s of minimum ~~*Generation*~~*generation*, in combination with one *primary plant outage*. The *primary plant outage* shall be taken to be that which, in combination with the minimum ~~*Generation*~~*generation*, leads to the lowest fault current at the particular location for the fault type under consideration.

Terminology	Definition
monitoring equipment	The testing instruments and devices used to record the performance of *plant* for comparison with expected performance.
month	Unless otherwise specified, the period beginning at 12.00 am on the *"*relevant commencement date*"* and ending at 12.00 am on the date in the *"*next calendar *month"* corresponding to the commencement date of the period. If the *"*relevant commencement date*"* is the 29th, 30th or 31st and this date does not exist in the *"*next calendar *month"*, then the end date in the *"*next calendar *month"* shall be taken as the last *day* of that *month*.
nameplate rating	The maximum continuous output or consumption in MW or MVA of an item of equipment as specified by the manufacturer.
NATA	National Association of Testing Authorities.
network	See definition for *electricity network*.
negotiated access standard	In relation to a technical requirement of access for a particular plant, an agreed standard of performance determined in accordance with this Code and identified as a negotiated access standard for that technical requirement in a connection agreement.
Network Access Code	The Northern Territory Electricity Networks (Third Party Access) Code ~~(Network Access Code)~~ that ~~is~~was established ~~in~~under Part 2 of the ~~TPA Act and the accompanying Schedule.~~Northern Territory *Electricity Networks (Third Party Access) Act* (now repealed).
network capability	The capability of the *network* or part of the *network* to transfer electrical *energy* from one location to another.
network losses	The *energy* loss incurred in the transportation of electricity from an entry or transfer point to an exit point or another transfer point on an *electricity network*.
Network Management Plan	A report prepared and published annually by the *Network Operator*. Amongst other things, this report contains the following details: • network limitations; • potential non-network and network solutions for small network investments; and • potential non-network and network solutions for large network investments.
Network Operator	A person defined as a "network provider" under section 4(1) of the *Electricity Reform Act* as in force at 1 July 2019 ~~body defined as a "network provider" in the *Electricity Networks (Third Party Access) Act* as in force at 1 February 2011~~. The *Network Operator* provides *access services* in respect of Power and Water's electricity network.
Network Operator's metering manuals	Specifications prepared by the *Network Operator* for equipment including *revenue metering* and communications enclosures, indoor and outdoor *revenue metering* units (*VT*s and CTs plus enclosure), CTs, *VT*s, marshalling boxes and wiring.
Network Planning Criteria	Criteria consistent with this *Code* prepared by the *Network Operator* which include the following: contingency criteria; steady-state criteria; stability criteria (transient, dynamic, *voltage*, and

Terminology	Definition
	frequency); *quality of supply* criteria (*voltage* limits, *voltage* fluctuation, system *frequency*, harmonic *voltage*, harmonic current, *voltage* unbalance, electro-magnetic interference) and environmental criteria.
Network User	Any person or body that has entered into a *connection agreement* with the *Network Operator* to convey electricity from an *entry point* to an *exit point*.
nomenclature standards	The standards approved by the *Network Operator* relating to numbering, terminology and abbreviations used for information transfer by *Users* as provided for in clause 4.9.
non-credible contingency event	A *contingency event* other than a *credible contingency event*. It means a *contingency event* in relation to which, in the circumstances, the probability of occurrence is considered by the *Network Operator* to be very low.
normal operating frequency band	In relation to the *frequency* of the *power system*, means the range specified in clause 2.2.1.
normal operating frequency excursion band	In relation to the *frequency* of the *power system*, means the range specified as being acceptable for infrequent and momentary excursions of *frequency* outside the *normal operating frequency band* being the range specified in clause 2.2.1.
NT NER	The National Electricity Rules as applicable in the Northern Territory.
operational communication	A communication concerning the arrangements for, or actual operation of the *power system* in accordance with the *Code*.
outage	Any planned or unplanned full or partial unavailability of *plant* or equipment.
peak load	Maximum *load*.
plant	Includes all equipment involved in generating, utilising or transmitting electrical *energy*.
post-trip management	The maintenance of system security in the aftermath of trips.
Power and Water Corporation	The body corporate established under the *Government Owned Corporations Act* as in force at 1 February 2011.
Power system security responsibilities	The responsibilities described in clause 4.3.
power factor	The ratio of the *active power* to the apparent power at a point.
power station	In relation to a *Generator*, a *facility* in which any of that *Generator*'s *generating units* ~~*Generation Units*~~ are located.
power system	The ~~*Generation*~~ *generation* facilities and *electricity network* facilities which together are integral to the *supply* of electricity, operated as an integrated arrangement.
Power System Controller	~~See definition in the Electricity Networks (Third Party Access) Act as in force at 1 February 2011. The *Power System Controller* controls the day-to-day dispatch of generators and associated ancillary services and the maintains power system security.~~ The entity licenced by the Utilities Commission pursuant to section 30 of

Terminology	Definition
	the Electricity Reform Act.
power system operating procedures	The procedures to be followed by *Users* in carrying out operations and /or maintenance activities on or in relation to primary and *secondary equipment connect*ed to or forming part of the *power system* or *connection point*s, as described in the System Control Technical Code ~~clause 4.6~~.
power system security	The safe scheduling, operation and control of the *power system* on a continuous basis in accordance with the principles set out in clause 4.2.3.
power system stabiliser	An auxiliary control device *connect*ed to an *excitation control system* to provide additional feedback signals to reduce *power system* oscillations.
power transfer	The instantaneous rate at which *active energy* is transferred between *connection point*s.
power transfer capability	The maximum permitted *power transfer* through a *network* or part thereof.
primary equipment, primary plant	Refers to apparatus which conducts *power system load* or conveys *power system voltage*.
protection	Used to describe the concept of detecting, limiting and removing the effects of *primary plant* or *primary equipment* faults from the *power system*. Also used to refer to the apparatus required to achieve this function.
protection apparatus	Includes all relays, meters, power circuit breakers, *synchroniser*s and other control devices necessary for the proper and safe operation of the *power system*.
protection scheme	A collection of one or more sets of *protection* for the purpose of protecting facilities and the *electricity network* from damage due to an electrical or mechanical fault or due to certain conditions of the *power system*.
protection system	A system which includes all the *protection scheme*s applied to the system.
quality of supply	Refers to, with respect to electricity, technical attributes to a standard referred to in clause 2.4, unless otherwise stated in this *Code* or a~~n~~ *connection ~~Access~~ ~~a~~Agreement*.
ramp rate	The rate of *change* of electrical power produced from a *generating unit~~Generation Unit~~*.
rate of change of frequency, (ROCOF)	The rate of change of power system frequency.
reactive energy	A measure, in var-hours (VArh) of the alternating ex*change* of stored *energy* in inductors and capacitors, which is the *time*-integral of the product of *voltage* and the out-of-phase component of current flow across a *connection point*.
reactive plant	*Plant* which is normally specifically provided to be capable of providing or absorbing *reactive power* and includes the *plant* identified in clause 3.6.7.

Terminology	Definition
reactive power	The rate at which *reactive energy* is transferred. *Reactive power* is a necessary component of alternating current electrical power which is separate from *active power* and is predominantly consumed in the creation of magnetic fields in motors and *transformers* and produced by *plant* such as: • alternating current *Generators*; • capacitors, including the capacitive effect of power lines; and • *synchronous condensers*.
reactive power capability	The maximum rate at which *reactive energy* may be transferred from a *generating unit* ~~*Generation Unit*~~ to a *connection point* as specified in a *connection agreement*.~~an *Access Agreement*.~~
reactive power reserve	Unutilised sources of *reactive power* arranged to be available to cater for the possibility of the unavailability of another source of *reactive power* or increased requirements for *reactive power*.
reactive power support/ reactive support	The provision of *reactive power*.
reactor	A device, similar to a *transformer*, specifically arranged to be *connect*ed into the *network* during periods of low *load demand* or low *reactive power demand* to counteract the natural capacitive effects of long *transmission line*s in generating excess *reactive power* and so correct any *voltage* effects during these periods.
reconnection	In respect of a *connection point*, means to operate switching equipment so as to restore the transfer of electricity through the *connection point*.
region, regional	An area determined by the *Network Operator*, being an area served by a particular part of the *transmission network* containing one or more major *load centre*s *or generation centres* or both.
regulating duty	In relation to a *generating unit*~~*Generation Unit*~~, the duty to have its *generated* output adjusted frequently so that any *power system frequency* variations can be corrected.
regulating frequency control ancillary services	Services to correct the *generation* / demand balance in response to minor deviations in *load* or *generation*.
reliability	The probability of a system, device, *plant* or equipment performing its function adequately for the period of *time* intended, under the operating conditions encountered.
reliable	The expression of a recognised degree of confidence in the certainty of an event or action occurring when expected.
remote back up protection	Refers to the detection and initiation of tripping at a location other than that at which the main *protection scheme* of the faulted *plant* is located. Remote back up *protection* provides a means of detecting and initiating clearance of *small zone fault*s or fault contributions supplied via failed circuit breakers.
remote control equipment (RCE), remote monitoring	Equipment installed to enable control or monitoring of a *facility* from a *control centre*, including a remote terminal unit (*RTU*).

Terminology	Definition
***equipment* (*RME*)**	
representative	In relation to a person, any employee, agent or Consultant of: (a) that person; or (b) a related body corporate of that person; or (c) a third party contractor to that person.
reserve	The *active power* and *reactive power* available to the *power system* at a nominated *time* but not currently utilised.
revenue meter	A device complying with *Australian Standard*s which measures and records the production or consumption of electrical *energy* that is used for obtaining the primary source of *revenue metering data*.
revenue metering installation	A *metering* installation used for recording the production or consumption of electrical *energy*.
revenue metering data	The data obtained from a *revenue metering installation*, the processed data or substituted data.
revenue metering database	A database of *revenue metering data*.
revenue metering point	The point of physical *connection* of the device measuring the current in the power conductor.
revenue metering register	A register of information associated with a *revenue metering installation* as required by clause 10.2.
revenue metering system	The collection of all components and arrangements installed or existing between each *revenue metering point* and the *revenue metering database*.
R-FCAS	Regulating frequency control ancillary services (a subset of FCAS)
RTU	A Remote Terminal Unit installed within a *substation* or *generator's facility* ~~generating station~~ to enable monitoring and control of a *facility* from a *control centre*.
satisfactory operating state	In relation to the *power system*, has the meaning given in clause 4.2.1.
SCADA system	Supervisory control and data acquisition equipment which enables the *Power System Controller* to continuously and remotely monitor, and to a limited extent control, the import or export of electricity from or to the *power system*.
scheduled ~~Generation Unit~~generating unit	A ~~*Generation*~~ *generating* ~~*Unit*~~ *unit* which ~~that~~ is *dispatched* by the *Power System Controller*.
secondary equipment, secondary plant	Those assets of a *facility* and the *electricity network* which do not carry the *energy* being traded, but which are required for control, *protection* or operation of assets that carry such *energy*.
secondary plant contingency	Any single failure of *secondary plant*.
secure operating state	In relation to the *power system* has the meaning given in clause 5.2.2.
sensitivity	In relation to *protection schemes*, has the meaning in clause 6.1.6.1.
settlements	The activity of producing bills and credit notes for *Users*.
single contingency	In respect of a *network*, a sequence of related events which result in the removal from service of one line, *transformer* or other item

Terminology	Definition
	of *plant*. The sequence of events may include the application and clearance of a fault of defined severity.
small network investment	A proposed investment in augmentation of the *network* or a non-*network* alternative with a capitalised net present value in excess of $1 Million that is not a *large network investment*.
Small Generator	A person who engages in the activity of owning, controlling or operating a *small generating system.*
~~Small Generator~~ ***small generating system***	A ~~*Generation Unit*~~*generating unit* or group of *generating units* ~~*Generation Units*~~ with: (1) aggregate rated capacity of no more than 2 MW or 10% of the minimum *demand* of an isolated *network*, whichever is the lesser; (2) *connect*ed to the 22 kV, 11 kV or *low voltage network*s; and (3) not subject to *dispatch* by the System Operator.
Small Generation Unit	A *generating unit* that forms part of a *small generating system.*
Small Inverter Energy System	A *Small Inverter Energy System* is a *generating unit* ~~*Generation Unit*~~ which uses an inverter that changes its direct-current power to alternating current power acceptable for power system connection. The nominal network voltages and maximum energy system capacities for which these requirements apply are: (1) 230 V single phase 10 kVA (2) 400 V three phase 30 kVA
small zone fault	A fault which occurs on an area of *plant* that is within the zone of detection of a *protection scheme*, but for which not all contributions will be cleared by the circuit breaker(s) tripped by that *protection scheme*. For example, a fault in the area of *plant* between a *current transformer* and a circuit breaker, fed from the *current transformer* side, may be a *small zone fault*.
spare network capacity	The capacity to transport electricity over a particular *electricity network* which the network provider assesses is in surplus to the capacity that existing end-use *customer*s forecast will be required to satisfy their reasonably foreseeable requirements for the transport of electricity.
spinning reserve	The ability to immediately and automatically increase ~~*Generation*~~ *generation* or reduce *demand* in response to a fall in *frequency*.
standby power	The amount of electrical *energy* which could be supplied to a *load User* in accordance with the terms of a standby ~~*Generation*~~ *generation* agreement.
static excitation system	An *excitation control system* in which the power to the rotor of a *synchronous* *generating unit* ~~*Generation Unit*~~ is transmitted through high power solid-state electronic devices.
static var compensator	A device specifically provided on a *network* to provide the ability to generate and absorb *reactive power* and to respond automatically and rapidly to *voltage* fluctuations or *voltage* instability arising from a disturbance or disruption on the *network*.
sub-network	A particular portion of the *network*.

Terminology	Definition
substation	A *facility* at which lines are switched for operational purposes. May include one or more *transformer*s so that some *connect*ed lines operate at different nominal *voltages* to others.
supply, supplying	The delivery of electricity.
synchronise	The act of *synchronising* a *generating unit* ~~*Generation Unit*~~ to the *power system*.
synchronised	In the case of a *generating unit*~~*Generation Unit*~~, to be *connected* to and *operate* at the same *frequency* as the *power system*.
synchronising, synchronisation	To electrically *connect* a *generating unit* ~~*Generation Unit*~~ to the *power system*.
synchronous condensers	*Plant*, similar in construction to a *generating unit* ~~*Generation Unit*~~ of the *synchronous Generator* category, which operates at the equivalent speed of the *frequency* of the *power system*, specifically provided to generate or absorb *reactive power* through the adjustment of excitation current.
~~***unsynchronised***~~	~~In the case of a *Generation Unit*, to operate *disconnected* from the power system, or to *operate* at a different *frequency* to the *power system* during an electrical disturbance.~~
~~***under frequency load shedding***~~	~~A *load shedding* scheme designed to automatically disconnect *load* on the *network* to restore *frequency* to the *normal operating range*.~~
~~***under frequency relay***~~	~~The component of an *under frequency load shedding* scheme that initiates disconnection of the *load*.~~
synchronous Generator voltage control	The automatic *voltage control system* of a *generating unit* ~~*Generation Unit*~~ of the *synchronous Generator* category which *change*s the output *voltage* of the *generating unit* ~~*Generation Unit*~~ through the adjustment of the *Generator* excitation current and effectively *change*s the *reactive power* output from that *generating unit*~~*Generation Unit*~~.
synchronous Generator, synchronous g~~G~~enerating~~on~~ u~~U~~nit	The alternating current *Generator*s which operate at the equivalent of the *frequency* of the *power system* in its *satisfactory operating state*.
tap-changing transformer	A *transformer* with the capability to allow internal adjustment of output *voltage*s which can be automatically or manually initiated and which is used as a major component in the control of the *voltage* of the *network*s in conjunction with the operation of *reactive plant*.
~~***technical envelope***~~	~~The limits described in clause 4.2.2.~~
teleprotection signalling	Equipment used to transfer a contact state from one location to another using communications equipment. The equipment used for this purpose will meet the *reliability* and quality requirements *protection* equipment.
time	Standard Time in the Northern Territory as defined by the *Standard Time Act 2005* (NT).~~Central *Australian Standard Time*, as defined by the *National Measurement Act*, 1960.~~
total fault clearance time	Refers to the *time* from fault inception to the *time* of complete fault interruption by a circuit breaker or circuit breakers.

Terminology	Definition
transformer	A *plant* or device that reduces or increases the *voltage* of alternating current.
transformer tap position	Where a tap *change*r is fitted to a *transformer*, each tap position represents a *change* in *voltage* ratio of the *transformer* which can be manually or automatically adjusted to *change* the *transformer* output *voltage*. The tap position is used as a reference for the output *voltage* of the *transformer*.
transmission element	A single identifiable major component of a *transmission network* involving: • an individual *transmission* circuit or a phase of that circuit; and • a major item of *transmission plant* necessary for the functioning of a particular *transmission* circuit or *connection point* (such as a *transformer* or a circuit breaker).
transmission line	A power line that is part of a *transmission network*.
transmission network	The components of the *electricity network* used for transmitting electricity at nominal *voltage*s of 66 kV or higher and at a nominal *frequency* of 50Hz.
transmission network connection point	A *connection point* on a *transmission network*.
transmission network test	Test conducted to verify the magnitude of the *power transfer capability* of the *transmission network* or investigating *power system* performance in accordance with clause 5.5.
transmission plant	Apparatus or equipment associated with the function or operation of a *transmission line* or an associated *substation*, which may include *transformer*s, circuit breakers, *reactive plant* and *monitoring equipment* and control equipment.
trip circuit supervision	A function incorporated within a *protection scheme* that results in alarming for loss of integrity of the *protection scheme'*s trip circuit. *Trip circuit supervision* supervises a *protection scheme'*s trip *supply* together with the integrity of associated wiring, cabling and circuit breaker trip coil.
trip supply supervision	A function incorporated within a *protection scheme* that results in alarming for loss of trip *supply*.
two fully independent protection schemes of differing principle	Where an item of *plant* is required to be protected by *two fully independent protection schemes of differing principle*, such *protection scheme*s shall, in combination, provide dependable clearance of faults on that *plant* within a specified *time*, with any single failure to operate of the *secondary plant*. To achieve this, complete *secondary plant* redundancy is required including, but not necessarily limited to, *current transformer* and *voltage transformer* secondaries, auxiliary supplies, signalling systems, cabling, wiring, and circuit breaker trip coils. Auxiliary supplies include DC supplies for *protection* purposes. Therefore, to satisfy the redundancy requirements, each fully independent *protection scheme* would need to have its own independent battery and battery charger

Terminology	Definition
	system *supplying* all that *protection scheme'*s trip functions. The *protection schemes* shall be so chosen as to have *differing principles* of operation.
under frequency load shedding	A *load shedding* scheme designed to automatically disconnect *load* on the *network* to restore *frequency* to the *normal operating range*.
~~***under frequency load shedding***~~	~~Equipment designed to automatically *disconnect load* from the *power system* if the *frequency* falls below a set level.~~
under voltage load shedding	Equipment designed to automatically *disconnect load* from the *power system* if the *voltage* falls below a set level.
under frequency relay	The component of an *under frequency load shedding* scheme that initiates disconnection of the *load*.
unsynchronised	In the case of a *generating unit*, to operate *disconnected* from the power system, or to *operate* at a different *frequency* to the *power system* during an electrical disturbance.
User	A person, whether a ~~*load*~~ *Network* *User* or a *Generator User*, who has been granted access to the *electricity network* by the *Network Operator* in order to transport electrical *energy* to or from a particular point.
use of system services	A *network* service provided to a *User* for use of the *electricity network* for the transportation of electrical *energy* that can be reasonably allocated to a *User* on a locational basis.
voltage	The electronic force or electric potential between two points that gives rise to the flow of electrical *energy*.
voltage control	Keeping *network voltage*s within operational limits in normal operation and in the aftermath of trips by automatic regulation of *generation* MVAr output or by *voltage control* equipment such as *capacitor bank*s and automatic tap-*changer*s.
voltage transformer (VT)	A *transformer* for use with meters and/or *protection* devices in which the *voltage* across the secondary terminals is, within prescribed error limits, proportional to and in phase with the *voltage* across the primary terminals.

Attachment 2 Rules of interpretation

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

(a) a reference in this *Code* to a contract or another instrument includes a reference to any amendment, variation or replacement of it;

(b) a reference to a person includes a reference to the person's executors, administrators, successors, substitutes (including, without limitation, persons taking by novation) and assigns;

(c) if an event shall occur on a *day* which is not a *business day* then the event shall occur on the next *business day*;

(d) any calculation shall be performed to the accuracy, in terms of a number of decimal places, determined by the *Network Operator* in respect of all *Users*;

(e) if examples of a particular kind of conduct, thing or condition are introduced by the word "including", then the examples are not to be taken as limiting the interpretation of that kind of conduct, thing or condition;

(f) a *connection* is a *User's connection* or a *connection* of a *User* if it is the subject of an *Access Agreement* between the *User* and the *Network Operator*; and

(g) a reference to a half hour is a reference to a 30 minute period ending on the hour or on the half hour and, when identified by a *time*, means the 30 minute period ending at that *time*.

Attachment 3 Technical details for *connection* and access

A3.1 Introduction

Various clauses of the *Code* require that *Users* submit technical data to the *Network Operator*. This attachment contains schedules which list the typical range of data which may be required. Data additional to those listed in the schedules may be required. The actual data required will be advised by the *Network Operator* at the *time* of assessment of a *network Access Application*, and will form part of the technical specification in the *Access Agreement*.

A3.2 Data categories

Data is ~~*Coded*~~ coded in categories, according to the stage at which it is available in the build-up of data during the process of forming a *connection* or obtaining access to a *network*, with data acquired at each stage being carried forward, or enhanced in subsequent stages, for example by testing.

A3.2.1 Preliminary system planning data

This is data required for submission with the *Access Application*, to allow the *Network Operator* to prepare an offer of terms for an *Access Agreement* and to assess the requirement for, and effect of, *network augmentation* or *extension* options. Such data is normally limited to the items denoted as Standard Planning Data (S) in the technical data schedules S3.1 to S3.7.

The *Network Operator* may, in cases where there is reasonable doubt as to the viability of a proposal, require the submission of other data before making an access offer to *connect* or to amend an *Access Agreement*.

A3.2.2 Registered system planning data

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

Registered data

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

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

A3.3 Data review

Data will be subject to review at reasonable intervals to ensure its continued accuracy and relevance. The *Network Operator* shall initiate this review. A *User* may *change* any data item at a *time* other than when that item would normally be reviewed or updated by submission to the *Network Operator* of the revised data, together with authentication documents, eg. test reports.

A3.4 Data schedules

Schedules S3.1 to S3.7 cover the following data areas:

(a) Schedule S3.1 - ~~*Generation*~~ *Generating* *Unit* Design Data. This comprises *Generation Unit* fixed design parameters.

(b) Schedule S3.2 - ~~*Generation*~~ *Generating* *Unit* Setting Data. This comprises settings which can be varied by agreement or by *direction* of the *Network Operator*.

(c) Schedule S3.3 – *Generator* data for small ~~*Generation Units*~~*generating units*

(d) Schedule S3.4 – Technical data for *Small Invertor Energy Units*

(e) Schedule S3.5 - *Network* and *Plant* Technical Data. This comprises fixed electrical parameters.

(f) Schedule S3.6 - *Plant* and Apparatus Setting Data. This comprises settings which can be varied by agreement or by *direction* of the *Network Operator*.

(g) Schedule S3.7 - *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 Non *synchronous Generators*

A *Generator* that *connects* a ~~*Generation*~~ *generating* ~~*Unit*~~*unit*, that is not a *synchronous* *generating unit*~~*Generation Unit*~~, shall be given exemption from complying with those parts of schedules S3.1 and S3.2 that are determined by the *Network Operator* to be not relevant to such *generating unit*~~*Generation Units*~~, but shall comply with those parts of Schedules S3.3, S3.5, and S3.6 that are relevant to such *generating units*~~*Generation Units*~~, as determined by the *Network Operator*.

Codes:

S = Standard Planning Data

D = Detailed Planning Data

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

Schedule S3.1 ~~Generation~~ *Generating* ~~Unit~~ *unit* design data

Symbol	Data Description	Units	Data Category
	***Power station* technical data:**		
	Connection point to *Network*	Text, diagram	S, D
	Nominal *voltage* at *connection* to *Network*	kV	S
	Total Station Net Maximum Capacity (NMC)	MW (sent out)	S, D, R2
	At *connection point*:		
	Maximum 3 phase short circuit infeed calculated by method of AS 3851 (1991):		
	• Symmetrical	kA	S, D
	• Asymmetrical	kA	D
	Minimum zero sequence impedance	% on 100 MVA base	D
	Minimum negative sequence impedance	% on 100 MVA base	D
	Short circuit ratio The lowest short circuit ratio at the *connection point* for which the *generating system*, including its *control systems*: (i) will be commissioned to maintain stable operation; and (ii) has the design capability to maintain stable operation. For the purposes of the above, “short circuit ratio” is the synchronous *three phase fault level* (expressed in MVA) at the *connection point* divided by the rated output of the *generating system* (expressed in MW or MVA).	Numeric ratio	S, D, R1
	Individual ~~*Generation Unit*~~*generating unit* data:		
MBASE	Rated MVA	MVA	S, D, R1
PSO	Rated MW (Sent Out)	MW (sent out)	S, D, R1
PMAX	Rated MW (*Generated*)	MW (Gen)	S, D
VT	Nominal Terminal *Voltage*	kV	S, D, R1
PAUX	Auxiliary *load* at PMAX	MW	S, D, R2
Qmax	Rated Reactive Output at PMAX	MVAr (sent out)	S, D, R1
PMIN	Minimum *Load* (ML)	MW (sent out)	S, D, R2

H	Turbine plus *Generator* Inertia Constant	MWs/rated MVA	S, D, R1
Hg	*Generator* Inertia Constant (applicable to synchronous condenser mode of operation)	MWs/rated MVA	S, D, R1
GSCR	Short Circuit Ratio		D, R1
ISTATOR	Rated Stator Current	A	D, R1
IROTOR	Rated Rotor Current at rated MVA and *Power factor*, rated terminal volts and rated speed	A	D, R1
VROTOR	Rotor *Voltage* at which IROTOR is achieved	V	D, R1
VCEIL	Rotor *Voltage* capable of being supplied for five seconds at rated speed during field forcing	V	D, R1
	***~~Generation~~ Generating unit* resistance:**		
RA	Stator Resistance	% on MBASE	S, D, R1, R2
RF	Rotor resistance at 20° C	ohms	S, D, R1
	***Generating unit ~~Generation 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 ~~Generation 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 ~~Generation Unit~~* reactances (unsaturated):**		
XD	Direct Axis Synchronous Reactance	% on MBASE	S, D, R1, R2
XD′	Direct Axis Transient Reactance	% on MBASE	S, D, R1, R2
XD″	Direct Axis Sub-Transient Reactance	% on MBASE	S, D, R1, R2
XQ	Quadrature Axis Synch Reactance	% on MBASE	S, D, R1, R2
XQ′	Quadrature Axis Transient Reactance	% on MBASE	S, D, R1, R2
XQ″	Quadrature Axis Sub-Transient Reactance	% on MBASE	S, D, R1, R2
XL	Stator Leakage Reactance	% on MBASE	S, D, R1, R2
XO	Zero Sequence Reactance	% on MBASE	S, D, R1
X2	Negative Sequence Reactance	% on MBASE	S, D, R1
XP	Potier Reactance	% on MBASE	S, D, R1
	***Generating unit ~~Generation Unit~~ time* constants (unsaturated):**		

TDO′	Direct Axis Open Circuit Transient	Seconds	S, D, R1, R2
TDO″	Direct Axis Open Circuit Sub-Transient	Seconds	S, D, R1, R2
TKD	Direct Axis Damper Leakage	Seconds	S, D, R1, R2
TQO′	Quadrature Axis Open Circuit Transient	Seconds	S, D, R1, R2
TQO″	Quadrature Axis Open Circuit Sub-Transient	Seconds	S, D, R1, R2
	Charts:		
GCD	Capability Chart	Graphical data	S, D, R1, R2
GOCC	Open Circuit Characteristic	Graphical data	R1
GSCC	Short Circuit Characteristic	Graphical data	R1
GZPC	Zero *power factor* curve	Graphical data	R1
	V curves	Graphical data	R1
GOTC	MW, MVAr outputs versus temperature chart	Graphical data	D, R1, R2
	Generating unit ~~***Generation Unit***~~ ***transformer*:**		
GTW	Number of windings	Text	S, D
GTR_n	Rated MVA of each winding	MVA	S, D, R1
$GTTR_n$	Principal tap rated *voltages*	kV/kV	S, D, R1
$GTZI_n$	Positive Sequence Impedances (each wdg)	(a - jb)% on 100 MVA base	S, D, R1
$GTZ2_n$	Negative Sequence Impedances (each wdg)	(a - jb)% on 100 MVA base	S, D, R1
$GTZ0_n$	Zero Sequence Impedances (each wdg)	(a - jb)% on 100 MVA base	S, D, R1
	Tapped Winding	Text, diagram	S, D, R1
GTAPR	Tap *Change* Range	kV - kV	S, D
GTAPS	Tap *Change* Step Size	%	S, D
	Tap *Change*r Type, On/Off *load*	On/Off	S, D
	Tap *Change* Cycle *Time*	Seconds	D
GTVG	Vector Group	Diagram	S, D
	Earthing Arrangement	Text, diagram	S, D
	Saturation curve	Diagram	R1
	Generating unit ~~***Generation Unit***~~ **reactive capability (at machine terminals):**		
	Lagging *Reactive power* at PMAX	MVAr export	S, D, R2
	Lagging *Reactive power* at ML	MVAr export	S, D, R2
	Lagging Reactive Short *Time* capability at rated MW, terminal *voltage* and speed	MVAr (for *time*)	D, R1, R2

Leading *Reactive power* at rated MW	MVAr import	S, D, R2

Generating unit ~~_Generation Unit_~~ excitation system:

Make		S, D
Model		S, D
General description of *excitation control system* (including functional block diagram)	Text, diagram	S, D
Rated Field *Voltage* at rated MVA and *Power factor* and rated terminal volts and speed	V	S, D, R1
Maximum Field *Voltage*	V	S, D, R1
Minimum Field *Voltage*	V	S, D, R1
Maximum rate of *change* of Field *Voltage*	Rising V/s	S, D, R1
Maximum rate of *change* of Field *Voltage*	Falling V/s	S, D, R1
Generating unit ~~*Generation Unit*~~ and exciter Saturation Characteristics 50 - 120%	Diagram	S, D, R1
Dynamic Characteristics of Over Excitation Limiter	Text/ Block diagram	S, D, R2
Dynamic Characteristics of Under Excitation Limiter	Text/ Block diagram	S, D, R2

~~_Generation_~~ _Generating_ ~~_Unit_~~ _unit_ _load controller_ (governor):

General description of governor *control system* (including functional block diagram). Format to be compatible with PSS/E software from Siemens PTI.	Text, diagram	S, D
Maximum Droop	%	S, D, R1
Normal Droop	%	D, R1
Minimum Droop	%	D, R1
Maximum *Frequency* Dead band	Hz	D, R1
Normal *Frequency* Dead band	Hz	D, R1
Minimum *Frequency* Dead band	Hz	D, R1
MW Dead band	MW	D, R1

~~_Generation_~~ _Generating_ _unit_ response capability:

Sustained response to *frequency change*	MW/Hz	D, R2
Non-sustained response to *frequency change*	MW/Hz	D, R2
Load Rejection Capability	MW	S, D, R2

	Mechanical shaft model:		
	(Multiple-stage steam turbine *Generator*s only)		
	Dynamic model of turbine/*Generator* shaft system in lumped element form showing component inertias, damping and shaft stiffness. Format to be compatible with PSS/E software from Siemens PTI.	Diagram	S, D
	Natural damping of shaft torsional oscillation modes (for each mode)		
	• Modal *frequency*	Hz	D
	• Logarithmic decrement	Nepers/Sec	D
	Steam turbine data:		
	(Multiple-stage steam turbines only)		
	Fraction of power produced by each stage:		
	Symbols KHP	Per unit of Pmax	D
	KIP		
	KLP1		
	KLP2		
	Stage and reheat *time* constants:		
	Symbols THP	Seconds	D
	TRH		
	TIP		
	TLP1		
	TLP2		
	Turbine *frequency* tolerance curve	Diagram	S, D, R1
	Gas turbine data:		
HRSG	Waste heat recovery boiler *time* constant (where applicable eg. for co*generation* equipment)	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 the ~~*Network Operator*~~*Network Operator*		

Wind farm/wind turbine data

	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 *generating unit* ~~*Generation Unit*~~		S, D, R1
	Long term flicker factor for wind farm		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. wind speed	Diagram	D
	Spatial Arrangement of wind farm	Diagram	D
	Startup profile MW, MVAr vs *time* for individual Wind Turbine Unit and Wind farm Total	Diagram	D
	Low Wind Shutdown profile MW, MVAr vs *time* for individual Wind Turbine Unit and Wind farm Total	Diagram	D
	MW, MVAr vs *time* profiles for individual Wind Turbine Unit under normal ramp up and ramp down conditions.	Diagram	D
	High Wind Shutdown profile MW, MVAr vs *time* for individual Wind Turbine Unit and Wind farm Total	Diagram	D

Induction *generating unit* ~~*Generation Unit*~~ data

	Make		
	Model		
	Type (squirrel cage, wound rotor, doubly fed)		
MBASE	Rated MVA	MVA	S,D,R1
	PSO Rated MW (Sent out)	MW	S,D,R1
	PMAX Rated MW (*generated*)	MW	D
	VT Nominal Terminal *Voltage* kV S,D,R1		
	Synchronous Speed	rpm	S,D,R1

	Rated Speed	rpm	S,D,R1
	Maximum Speed	rpm	S,D,R1
	Rated *Frequency*	Hz	S,D,R1
Qmax	Reactive consumption at PMAX	MVAr import	S,D,R1
	Curves showing torque, *power factor*, efficiency, stator current, MW output versus slip (+ and -).	Graphical data	D,R1,R2
	Number of *capacitor bank*s 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 *connect*ed to the *generating unit* ~~*Generation Unit*~~ shaft (for example, *generating unit*~~*Generation Unit*~~, turbine, gearbox, etc.) calculated at the synchronous speed	MW-sec/MVA	S,D,R1
	Resistance		
Rs	Stator resistance	% on MBASE	D,R1
Rs	Stator resistance versus slip curve, or two extreme values for zero (nominal) and unity (negative) slip	Graphical data or % on MBASE	D,R1
	Reactances (saturated)		
X′	Transient reactance	% on MBASE	D,R1
X″	Subtransient reactance	% on MBASE	D,R1
	Reactances (unsaturated)		
X	Sum of magnetising and primary winding leakage reactance.	% on MBASE	D,R1
X′	Transient reactance	% on MBASE	D,R1
X″	Subtransient reactance	% on MBASE	D,R1
Xl	Primary winding leakage reactance	% on MBASE	D,R1
	***Time* constants (unsaturated)**		
T′	Transient	sec	S,D,R1,R2
T″	Subtransient	sec	S,D,R1,R2
Ta	Armature	sec	S,D,R1,R2
To′	Open circuit transient	sec	S,D,R1,R2
To″	Open circuit subtransient	sec	S,D,R1,R2

Converter data

Control: *transmission* system commutated or self commutated

Additional data may be required by the *Network Operator*

Doubly fed induction *generating unit* ~~*Generation Unit*~~ data

Required data will be advised by the *Network Operator*

Schedule S3.2 *Generating unit* ~~*Generation Unit*~~ setting data

Description Category	Units	Data Category
***Protection* data:**		
Settings of the following *protections*:		
Loss of field	Text	D
Under excitation	Text, diagram	D
Over excitation	Text, diagram	D
Differential	Text	D
Under frequency	Text	D
Over *frequency*	Text	D
Negative sequence component	Text	D
Stator over *voltage*	Text	D
Stator overcurrent	Text	D
Rotor overcurrent	Text	D
Reverse power	Text	D
Stator E/F	Text	D
Rotor E/F	Text	D
Out of step	Text	D
Control Data:		
Details of *excitation control system* described in block diagram form showing transfer functions of individual elements, parameters and measurement units (in Siemens PTI PSS/E format).	Text, diagram	S, D, R1, R2
Automatic *voltage* regulator	Text, diagram	S, D, R1, R2
Power system stabiliser	Text, diagram	S, D, R1, R2
Settings of the following controls:		
Details of the *governor system* described in block diagram form showing transfer functions of individual elements and measurement units (in Siemens PTI PSS/E format).	Text, diagram	S, D, R1, R2
Over excitation limiter	Text, diagram	S, D
Under excitation limiter	Text, diagram	S, D
Stator current limiter (if fitted)	Text, diagram	S, D
Manual restrictive limiter (if fitted)	Text	S, D
Load drop compensation/VAr sharing (if fitted)	Text, function	S, D
V/f limiter (if fitted)	Text, diagram	S, D

Schedule S3.3 *Generator* data for small generating systems~~Generation Units~~

Power station	Data Category
Address	S, R1
Description of *power station*, for example, is it a green or brownfield site, is there a process steam or heat requirement, any other relevant information	S
Site-specific issues which may affect access to site or design, eg. other construction onsite, mine site, environmental issues, soil conditions	S, D
Number of *generating unit* ~~*Generation Units*~~ and ratings (kW)	S, D, R1
Type: eg. synchronous, induction	S, D, R1
Manufacturer	D
Connected to the *network* via: eg. inverter, *transformer*, u/g cable etc.	S
Prime mover types: eg. reciprocating, turbine, hydraulic, photovoltaic, other	S
Manufacturer	D
Energy source: eg. natural gas, landfill gas, distillate, wind, solar, other	S
Total *power station* total capacity (kW)	S, D, R1
Power station export capacity (kVA)	S, D, R1
Forecast annual *energy* ~~*Generation*~~ *generation* (kWh)	S, D
Normal mode of operation as per clause 3.4.3 of the *Network Technical Code* ie. (1) continuous parallel operation (2) occasional parallel operation (3) short term test parallel operation (4) bumpless (make before break) transfer (i) rapid transfer (ii) gradual transfer	S
Purpose: eg. power sales, peak lopping, *demand* management, exercising, emergency back up	S

Schedule S3.4 Technical data for *Small Inverter Energy Systems*

Description	Units	Data Category
Address	Text	S
Number of *Small Inverter Energy Systems* and ratings	kW	S, D
Manufacturer	Text	D
Connection *voltage*		
Nominal *voltage*	V	S, D
Single/three phase	Number	S, D

Schedule S3.5 *Network* and *plant* technical data

Description	Units	Data Category
***Voltage* rating**		
Nominal *voltage*	kV	S, D
Highest *voltage*	kV	D
Insulation co-ordination		
Rated lightning impulse withstand *voltage*	kVp	D
Rated short duration power *frequency* withstand *voltage*	kV	D
Rated currents		
Circuit maximum current	kA	S, D
Rated Short *Time* Withstand Current	kA for seconds	D
Ambient conditions under which above current applies	Text	S,D
Earthing		
System Earthing Method	Text	S, D
Earth grid rated current	kA for seconds	D
Insulation pollution performance		
Minimum total creepage	mm	D
Pollution level	Level of IEC 815	D
Controls		
Remote control and data *transmission* arrangements	Text	D
***Metering* provided by customer**		
Measurement *transformer* ratios:		D
Current *transformers*	A/A	D
Voltage transformers	V/kV	D
Measurement *Transformer* Test Certification details	Text	R1
***Network* configuration**		
Operation Diagrams showing the electrical circuits of the existing and proposed main facilities within the *User's* ownership including *busbar* arrangements, phasing arrangements, earthing arrangements, switching facilities and operating *voltages*	Single line Diagrams	S, D, R1

***Network* impedances**

For each item of *plant* (including lines): details of the positive, negative and zero sequence series and shunt impedances, including mutual coupling between physically adjacent elements.	% on 100 MVA base	S, D, R1

Short circuit infeed to the *network*

Maximum *Generator* 3-phase short circuit infeed including infeeds from *generating units* ~~*Generation Units*~~ *connect*ed to the *User's* system, calculated by method of AS 3851 (1991).	kA symmetrical	S, D, R1
The total infeed at the instant of fault (including contribution of induction motors).	kA	D, R1
Minimum zero sequence impedance of *User's network* at *connection point*.	% on 100 MVA base	D, R1
Minimum negative sequence impedance of *User's network* at *connection point*.	% on 100 MVA base	D, R1

***Load* Transfer Capability:**

Where a *load*, or group of *load*s, may be fed from alternative *connection points*:		
Load normally taken from *connection point* X	MW	D, R1
Load normally taken from *connection point* Y	MW	D, R1
Arrangements for transfer under planned or fault *outage* conditions	Text	D

Circuits Connecting Embedded *generating units* ~~*Generation Units*~~ to the *Network*:

For all *generating units*~~*Generation Units*~~, all *connect*ing lines/cables, *transformer*s etc.		
Series Resistance (-ve, -ve & zero seq.)	% on 100 MVA base	S, D, R
Series Reactance (-ve, -ve & zero seq.)	% on 100 MVA base	S, D, R
Shunt Susceptance (-ve, -ve & zero seq.)	% on 100 MVA base	S, D, R
Normal and short-*time* emergency ratings	MVA	S, D, R
Technical Details of *generating units* ~~*Generation Units*~~ as per schedules S1, S2, S3.		

***Transformer*s at *connection points*:**

Saturation curve	Diagram	R

Schedule S3.6 *Network plant* and apparatus setting data

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

Schedule S3.7 *Load* characteristics at *connection point*

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

Schedule S4 Grace periods for purposes of clause 12.3

Clause	Clause Title	Transition to Compliance Grace Period
3.3.5.1	Reactive power capability	13 months
3.3.5.2	Quality of electricity generated	30 days
3.3.5.3	Generation unit response to frequency disturbance	30 days
3.3.5.4	Generating System Response to Voltage Disturbances	13 months
3.3.5.5	Generating System Response to Disturbances Following Contingency Events	6 months
3.3.5.6	Quality of Electricity Generated and Continuous Uninterrupted Operation	30 days
3.3.5.7	Partial Load Rejection	30 days
3.3.5.8	Protection of Generation Units from Power System Disturbances	30 days
3.3.5.9	Protection Systems that Impact on Power System Security	30 days
3.3.5.10	Protection to Trip Plant for Unstable Operation	30 days
3.3.5.11	Frequency Control	30 days
3.3.5.12	Impact on Network Capability	30 days
3.3.5.13	Voltage and Reactive Power Control	30 days
3.3.5.14	Active Power Control	30 days
3.3.5.15	Inertia and Contingency FCAS	30 days
3.3.5.16	System Strength	30 days
3.3.5.17	Capacity Forecasting	13 months
3.3.6.1	Remote Monitoring and Control	30 days
3.3.6.2	Communications Equipment	30 days

Explanatory notes:

1. The transition to compliance timeframes includes the 30 days for the generator to provide a compliance plan and confirm GPS.
2. The transition to compliance grace periods include all aspects including design, modelling, procurement, programming, installation and testing as appropriate.
3. Clauses with 30 day timeframe to compliance reflect that the requirements are either:
   a. The same or equivalent outcome as those under the existing NTC V3.1; or
   b. Not expected to result in a compliance gap.
4. For the clause with a 6 month timeframe, a compliance gap is considered at least possible, with any gap most likely related to a programming / setting change and testing to demonstrate compliance.
5. For the clauses with a 13 month timeframe, a potential compliance gap is considered possible, with that gap most likely related to requiring additional plant or equipment and testing to demonstrate compliance.

~~1.~~6. A generator may seek an extended derogation under NTC clause 12.1, but only where it can be justified, and the generator demonstrates its best endeavours to achieve timely compliance.

Attachment 4 *Metering* requirements

A4.1 General

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

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

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

(d) *Revenue metering equipment* will comprise a *revenue metering* unit containing *voltage transformer*s (*VT*s) and *current transformer*s (*CT*s), or for system *voltage*s of 66 kV and 132 kV, free standing post type *VT*s and *CT*s (other than free standing post type *VT*s and *CT*s may be acceptable and each request will be considered), two or more *revenue meter*s, cabling, communications equipment, marshalling box and a *revenue meter* enclosure.

A4.2 Installation

(a) The maximum cable route length between the *CT*s and *VT*s and the *revenue meter*s is 80 metres.

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

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

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

A4.3 3-4 wire *metering*

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

(b) The *Network Operator* will, if requested by a *User*, advise the *User* whether an installation is 3-wire or 4-wire.

A4.4 Signals

(a) Signals comprising *energy* usage information may be made available via volt free relay contacts rated to 30V AC or DC at a maximum of 60 mA. These signals comprise momentary relay closures each *time* a given amount of *energy* (kWh) is imported or exported and each *time* a given number of kVArh is imported, the start of each 30 minute *demand* period (or other period if appropriate) and relay closures when the rate *change*s (on-peak or off-peak or shoulder etc.).

A4.5 Accuracy requirements

Table A4.1 - Overall Accuracy Requirements of *Revenue metering installation*

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

Note to Table A4.1:

The method for calculating the overall error is the vector sum of the errors of each component part, ie. a - b - c, where:

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

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

c = the error of the *revenue meter*.

A4.6 Other *metering* requirements

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

Attachment 5 Test schedule

The following test schedule is used for specific performance verification and model validation.

A5.1 General

(a) Recorders should be calibrated or checked prior to use.

(b) Recorders should not interact with any *plant* control functions.

(c) Galvanic isolation and filtering of input signals should be provided whenever necessary.

A5.2 Test preparation and presentation of test results

Information/data prior to tests

(a) a detailed schedule of tests agreed by the ~~*Network Operator*~~*Network Operator*. The schedule should list the tests, when each test is to occur and whose responsibility it will be to perform the test.

(b) Schematics of equipment and *sub-networks* plus descriptive material necessary to draw up/agree upon a schedule of tests

(c) Most up to date relevant technical data and parameter settings of equipment as specified in Attachment 3 of this *Code*.

Test notification

(a) Prior notice of test commencement should be given to the *Network Operator* for the purpose of arranging witnessing of tests.

(b) The *Network Operator's representative* should be consulted about proposed test schedules, be kept informed about the current state of the testing program, and give permission to proceed before each test is carried out.

Test results

(a) Test result data shall be presented to the *Network Operator* within 5 *business days* of completion of each test or test series.

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

A5.3 Quantities to be measured

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

***Generator* and excitation system**

- stator L-N terminal *voltages*
- stator terminal currents

- *Active power* MW
- *Reactive power* MVAr
- *Generator* rotor field *voltage*
- *Generator* rotor field current
- Main exciter field *voltage*
- Main exciter field current
- AVR reference *voltage*
- *Voltage* applied to AVR summing junction (step etc.)
- *Power system stabiliser* output
- DC signal input to AVR which corresponds to terminal volts

Steam turbine

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

Gas turbine

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

Reciprocating engine

- Engine crank speed driving the *Generator*
- Type of governor *load* / speed control
- Ambient / charge air / exhaust temperature

- Fuel flow

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

(c) Key quantities such as stator terminal *voltage*s, currents, *active power* and *reactive power* of the other *generating units* ~~*Generation Units*~~ *connect*ed on the same bus and also *interconnection* lines with the *Network Operator's network* (from control room readings) before and after each test shall also be provided.

Schedule of Tests

Test No	TEST DESCRIPTION General Description	*Changes* Applied	Test Conditions
C1	Step *change* to AVR *voltage* reference with the *Generator* on **open circuit**	(a) -2.5% (b) –2.5% (c) -5.0% (d) –5.0%	nominal stator terminal volts
C2	Step *change* to AVR *voltage* reference with the *Generator connect*ed to the system at the following outputs 50% rated MW 100% rated MW	(a) -1.0% (b) –1.0% (c) -2.5% (d) –2.5% (e) -5.0% (f) –5.0% repeat (e) & (f) twice see notes below	nominal stator terminal volts unity or lagging *power factor* system base *load* *Generator* outputs: (i) 50% rated MW (ii) 100 % rated MW all tests in (i) should precede test in (ii) smaller step *change*s should precede larger step *changes*
C3	As for C2 but with the *power system stabiliser* in service and with the system conditions (i) and (ii) as indicated in column 3 (Test Conditions)	As in C2	As in C2, but system base *load* with no other ~~*Generation*~~ *generation* on the same bus system maximum *load* and maximum ~~*Generation*~~ *generation* on same bus
C4	Manual variation of *Generator* open circuit *voltage*	Stator terminal *voltage* (U_t) (a) increase from 0.5 pu to 1.1 pu (b) decrease from 1.1 pu to 0.5 pu	in 0.1 pu step for U_t between 0.5 – 0.9 pu on 0.5 pu step for U_t between 0.9 – 1.1 pu
C5	*Load* rejection (*active power*)	(a) 25% rated MW (b) 50% rated MW (c) 100% rated MW	nominal stator terminal volts unity *power factor* smaller amount should precede larger amount of lead rejection
C6	*Load* rejection (*reactive power*)	(5) –30% rated MVAr (6) -25% rated MVAr	nominal stator terminal volts 0 or minimum MW output
C7	*Load* rejection (*reactive power*)	(a) –30% rated MVAr	nominal stator terminal volts Excitation Manual Control

~~**Attachment 6 *Access Application* schedule**~~

~~**The following Schedule of information to be submitted in an *Access Application* is pursuant to Schedule 2 of the Electricity Networks (Third Party Access) Code.**~~

~~**A6.1 *Access Application* information requirements**~~

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

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

~~(c) **An *Access Application* may only be made for the provision of *access services* that the applicant wishes the *Network Operator* to commence to provide within 3 years of the date of the *Access Application*.**~~

~~(d) **An *Access Application* shall contain the following information:**~~

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

~~The following clauses are intended to provide a guide for existing and intending *Network Users* (*Access Applicants*) on the process of *connection* to the network. Full details of the network connection procedures and the obligations of participants and the *Network Operator* are contained in Chapter 2 and Schedules 2, to 5 of the Electricity Networks (Third Party Access) Code.~~

~~**A6.2 *Access Application***~~

~~(a) The *Access Applicant* must lodge a written *Access Application* to the *Network Operator* containing the relevant information set out in Schedule 2 of the Electricity Networks (Third Party Access) Code.~~

~~(b) If necessary, the *Network Operator* may request further information from the *Access Applicant* within 7 days of its lodgement.~~

~~(c) Within 7 days of receiving an *Access Application* or further information, the *Network Operator* must notify:~~

~~(1) the Utilities Commission; and~~

~~(2) any *Network User* that would be materially affected by the *Access Application*.~~

~~A6.3 Initial response to *Access Application* by the *Network Operator*~~

~~(a) The *Network Operator* shall provide the *Access Applicant* with a written initial response to an *Access Application*:~~

~~(1) within 10 *days* of receiving an *Access Application* from an existing *Network User; or*~~

~~(2) within 21 *days* of receiving an *Access Application* from a new *Network User; or*~~

~~(3) where the *Network Operator* has requested further information, within an equivalent period after receiving that information.~~

~~(b) The initial response by the *Network Operator* in respect of an *Access Application* shall include the following information:~~

~~(1) the period within which the *Network Operator* is able to make a preliminary assessment of the *Access Application*; and~~

~~(2) an estimate of the reasonable expenses expected to be incurred by the *Network Operator* in processing the *Access Application*, preparing an initial response, carrying out a preliminary assessment, making an offer and negotiating the *Access Agreement*.~~

~~A6.4 Preliminary assessment of *Access Application* by the *Network Operator*~~

~~(a) If a preliminary assessment is requested in the *Access Application*, the *Network Operator* must make the assessment and give the *Access Applicant* a report of the assessment within the time period specified in the initial response to the *Access Application*.~~

~~(b) A preliminary assessment shall include the following information:~~

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

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

~~(3) whether or not a capital contribution will be required of the *Access Applicant* and if so, an indication of the likely amount of that capital contribution;~~

~~(c) The information provided under clauses A6.3(b)(1), (b)(2) and (b)(3) above may be subject to change under conditions specified by the *Network Operator* in the preliminary assessment.~~

~~A6.5 Access offer~~

~~(a) The *Network Operator* must make an access offer to provide to the *Access Applicant* the network *access services* requested in the *Access Application* within:~~

~~(1) 30 days of receiving the request; or~~

~~(2) if within that period the *Network Operator* has requested further information, within 30 days after receiving the information;~~

~~unless agreed by the *Access Applicant* and the *Network Operator*, or as otherwise approved by the Utilities Commission.~~

~~(b) The access offer by the *Network Operator* may require the *Access Applicant* to make a contribution towards capital investment to provide the requested access.~~

~~(c) If the *Access Applicant* does not conclude negotiations with the *Network Operator* within 60 days, the access offer expires and the *Access Application* lapses.~~

~~A6.6 *Access Agreement*~~

~~(a) The *Network Operator* will prepare an *Access Agreement* setting out the specific technical, commercial and legal conditions under which access to the network is provided, in accordance with Schedule 4 of the Electricity Networks (Third Party Access) Code.~~

~~(b) The *Access Applicant* must execute the *Access Agreement* before a new or modified *connection* will be made to the *network* and is required to abide by the terms and conditions of the *Access Agreement* and this *Code*.~~

System Control Technical Code

Version No: ~~5.0~~6.0 (as marked up to seek approval)

~~April 2015~~ September 2019

[THIS VERSION IS MARKED UP AS AT 4 SEPTEMBER 2019 TO SHOW PROPOSED CHANGES.
FOLLOWING APPROVAL AND BEFORE PUBLICATION, THE DOCUMENT WILL BE REFORMATTED AND REPAGINATED IN CURRENT TEMPLATES]

Prepared by: Power and Water Corporation as the System Control Licence holder

Approved by: NT Utilities Commission

Power and Water Corporation
ABN 15 947 352 360
www.powerwater.com.au

Version History – see Attachment 3

Table of Contents

SECTION 1

1 INTRODUCTION

1.1 AUTHORISATION

This ~~*Technical*~~ *Code* is prepared pursuant to the system control licence issued by the Utilities Commission and clause 38 of the Electricity Reform Act and establishes the:

(a) performance standards of *power systems* in the Northern Territory;

(b) operation requirements which apply to the operation of *System Participants' plant* and *equipment connected* to a *power system*;

(c) requirements for the operation of a *power system* under normal and *emergency* circumstances, the latter including the possibility of a person suffering injury;

(d) operational obligations of *System Participant*s;

(e) procedures which apply if the *Power System Controller* believes that a *System Participant's plant* or *equipment* does not comply with the requirements of the ~~*Technical*~~ *Code*;

(f) procedures relating to the inspection of a *System Participant's plant* and *equipment*;

(g) procedures which apply to system tests and work carried out in relation to all or a part of a *power system*;

(h) coordinate procedures which apply to the commissioning and testing of new *plant* and *equipment connected* to a *power system*;

(i) procedures which apply to the *disconnection* of *plant* and *equipment* from a *power system*;

(j) procedures relating to the operation of *generating unit*s and other *plant* and *equipment* as part of or *connected* to a *power system* (including the issue of *dispatch instructions* and compliance with those instructions);

(k) metering and *energy settlements* requirements in relation to *connection*s;

(l) information which each *System Participant* is required to provide to the *Power System Controller* in relation to the operation of *plant* and *equipment connected* to a *power system* at the *System Participant's connection*s and the manner and timing of that information;

(m) requirements in relation to under *frequency load shedding* with which *System Participants* shall comply; and

(n) any other operational matters relating to a *power system* or *plant* and *equipment connected* directly or indirectly to a *power system*.

1.2 STATEMENT OF PURPOSE

This *Code* sets out:

(a) requirements to achieve a *secure system*;

(b) procedures for *generation plant* scheduling and *ancillary services*;

(c) requirements relating to the operation of a *power system* and *equipment connected* to a *power system*;

(d) *quality of supply* standards which apply at points of *connection* to a *power system*;

(e) requirements that are placed on all *System Participants* to ensure that the technical performance of an *interconnected power system* meets all the requirements of this ~~*Technical*~~ *Code* and the *Network Technical Code*; and

(f) provisions pursuant to which the *I-NTEM* will be operated and administered with respect to the *Darwin Katherine power system*.

1.3 APPLICATION

This *Code* applies to the following organisations and *System Participant*s:

(a) *Power System Controller* under the System Control Licence;

(b) *Market Operator*, a function of the *Power System Controller* and pursuant to the *Electricity Reform (Administration) Regulations*;

(c) *Network Operators* under their Network Operators Licences;

(d) *Generators* under their Generation Licences;

(e) *Market Customers* under their Retail Licences; and

(f) any other *customer*s ~~and~~ or *Network Users* of power systems, and/or elements of *power system*s, ~~as directed~~ that are regulated by the Utilities Commission.

1.4 INTERPRETATION

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

(b) This ~~*Technical*~~ *Code* shall be interpreted in accordance with the rules of interpretation set out in Attachment 2, unless the contrary intention appears.

(c) If there is conflict in relation to *power system security* and operational issues and procedures between this *Code* and the *Network Technical Code* or any other procedures of *System Participant*s, the requirements of this *Code* shall prevail. All such conflicts will be dealt with by the *Power System Controller* and the *Network Operator*; relevant *System Participants* will also be consulted.

(d) If there is conflict in relation to market operational issues and procedures between this *Code* and the *Ring Fencing Code*, the requirements of the *Ring Fencing Code* shall prevail. All such conflicts will be dealt with by the *Power System Controller* and the Utilities Commission; relevant *System Participants* will also be consulted.

1.5 DISPUTE RESOLUTION

(a) Should a dispute arise between a *System Participant* and the *Power System Controller* concerning this ~~*Technical*~~ *Code*, the *Power System Controller* shall negotiate with the *System Participant* to determine mutually acceptable outcomes. If agreement cannot be reached between these two parties within 14 *day*s, the parties must request the assistance of the Utilities Commission to resolve the dispute.

(b) Should a dispute arise between a *Market Participant* and the *Market Operator*, the *Market Operator* shall negotiate with the *Market Participant* to determine mutually acceptable outcomes. If agreement cannot be reached between these two parties within 14 *days*, the parties must request the assistance of the Utilities Commission to resolve the disputes.

1.6 CONFIDENTIALITY

A *System Participant*, together with Government agencies shall preserve the confidential nature of the *confidential information*.

1.7 OBLIGATIONS

1.7.1 Obligations of *System Participant*s

(a) All *System Participants* shall:

(1) maintain and operate all *equipment* being part of their facilities in accordance with:

(i) relevant laws;

(ii) the requirements of this *Code*;

(iii) the requirements of the *Network Technical Code*;

(iv) *good electricity industry practice* and applicable Australian Standards; and

(b) respond, within reasonable *time*, to any reasonable request of the *Power System Controller* for data or records, including any metering data or relevant operational information, in *connection* with the operation of the *power system* or the *I-NTEM*.

1.7.2 Obligations of the *Network Operator*

(a) *Network Technical Code* outlines the obligations of the *Network Operator*.

(b) The *Network Operator* shall comply with the relevant *power system* performance and *quality of supply* standards:

(1) described in this *Code* and the *Network Technical Code*;

(2) in accordance with *access agreement*s with another *System Participant*; and

(3) in accordance with standards of service set by the Utilities Commission

(c) The *Network Operator* shall respond, within reasonable *time*, to the reasonable request of the *Power System Controller* for operational data or records or relevant operation information of their *plant*.

(d) The *Network Operator* must fulfil the responsibilities and comply with the requirements and obligations imposed upon it in Attachment 6 and Attachment 7.

1.7.3 Obligations of *Generators*

A *Generator* shall comply at all times with applicable requirements and conditions of *connection* for *generating units* and, in accordance with any *access agreement* with the *Network Operator*. Each *Generator* shall:

(a) comply with the requirements of the *Network Technical Code* and System Control Technical Code in respect of design and operation requirements of *equipment connected* to a *power system*;

(b) permit and participate in inspection and testing of facilities;

(c) permit and participate in commissioning of facilities and *equipment* which are to be *connected* to a *power system* for the first *time*;

(d) operate facilities and *equipment* in accordance with *direction* given by the *Network Operator* and the *Power System Controller*;

(e) give 30 *days* notice of intended voluntary *disconnection*;

(f) respond, within reasonable *time*, to the reasonable request of the *Power System Controller* for operational data or records or relevant operation information of their *plant*; and

(g) comply with the requirements and obligations imposed upon it in Attachment 6 and Attachment 7.

1.7.4 Obligations of the *Power System Controller*

(a) The operational functions and powers of the *Power System Controller* are set out in Section 38 of the Electricity Reform Act and are carried out by the System Control Licence holder:

(1) power to issue *directions* to electricity entities that are engaged in the operation of a *power system*, or contribute electricity to, or take electricity from, a *power system*;

~~(1)~~(2) Without limiting paragraph (1), ~~the~~ directions ~~(~~to electricity entities (~~,~~ referred to in the *Code* as *System Participants*) may include directions:

a. to switch off or re-route a *Generator*;

b. to call *equipment* into service;

c. to take *equipment* out of service;

d. to commence operation or maintain, increase or reduce active or *reactive power* output;

e. to shut down or vary operation;

f. to shed or restore *customer loads*; and

g. in relation to other powers conferred by the Regulations.

(b) The *Power System Controller* has the function of monitoring and overseeing the operation of each regulated *power system* to ensure that the system operates reliably, safely and securely in accordance with the Ring Fencing Code, ~~Electricity Network (Third Party Access) Code~~the Electricity Reform Act~~,~~ the Electricity Reform (Administration) Regulations, *Network Technical Code*, System Control Technical Code and other relevant Codes and Standards.

(c) The *Power System Controller* is responsible for the setting of target *frequency* of the *power system* and the arrangements to provide associated *ancillary services* for the maintenance of system security.

(d) The *Power System Controller* is responsible for the establishment of operating protocol and arrangements for *generation dispatch* and to maintain *power system security*.

(e) The *Power System Controller* shall arrange for operation of a *power system* such that:

(1) in the *satisfactory operating state*, electricity may be transferred continuously in a secure and efficient manner;

(2) the number of interruptions to *customer*s is minimised;

(3) restoration of a *power system* shall occur as soon as reasonably practical following any interruption within the relevant *power system*;

(f) The *Power System Controller* is responsible for ensuring that the technical parameters of *Network equipment* and *System Participant*s' *equipment* comply with the standards set out in the *Network Technical Code* or as set out in an ~~*Access*~~ *access* ~~*Agreement*~~ *agreement* with the *System Participant*; and

(g) The *Power System Controller* must fulfil the responsibilities and comply with the requirements and obligations imposed upon it in Attachment 6 and Attachment 7.

1.7.5 Obligations of the *Market Operator*

(a) The *Market Operator* must fulfil the responsibilities and comply with the requirements and obligations imposed upon it in Attachment 6.

1.8 VARIATIONS AND EXEMPTIONS FROM, AND AMENDMENTS TO, THE *CODE*

1.8.1 Variations and exemptions to the *Code*

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

(a) the agreement of the *Power System Controller*, and

(b) *access agreement* conditions.

In all cases any such variation or exemption shall be given in writing to *System Participants* by the *Power System Controller*.

1.8.2 Amendments to the *Code*

(a) Any *System Participant* or electricity entity that holds a current Licence may propose an amendment to this *Code*.

(b) A proposal to amend the *Code* shall be made in writing by the *System Participant* or electricity entity to the *Power System Controller* and shall be accompanied by:

(1) the reasons for the proposed amendment to the *Code*; and

(2) an explanation of the effect on *System Participants* of the proposed amendment to the *Code*.

(c) The *Power System Controller* shall review the proposed amendment to the *Code* and within 30 *days* advise the *System Participant* or electricity entity:

(1) whether the proposed amendment to the *Code* is accepted or rejected; and

(2) the reasons for the acceptance or rejection of the proposed amendment to the *Code*.

(d) The *Power System Controller* shall review the operation of this *Code* at intervals of no more than 5 years and may seek submissions from *System Participants* and the Utilities Commission during the course of the review.

(e) The *Power System Controller* may amend the *Code* at any *time*, but only with the prior written approval of the Utilities Commission.

(f) The *Power System Controller* shall consult with all electricity entities that hold a current market Licence, when amending the *Code*.

(g) The *Power System Controller* must *publish* the consultation submissions of stakeholders at the time of the *Code's* approval by the Utilities Commission unless advised in writing that the submission contains commercially sensitive information and a reason is included to justify that request.

1.9 *I-NTEM* TRANSITIONAL PROVISIONS

If the *Power System Controller* is required to consult with *System Participants* or electricity *Market Participants* before:

(a) making a determination;

(b) *publishing* a document;

(c) exercising a power; or

(d) discharging an obligation,

under this *Code* ('consultation obligation'), any consultation undertaken by the *Power System Controller* prior to the approval of the *Code* will be deemed to constitute consultation undertaken by the *Power System Controller* under the *Code*.

SECTION 2

2 OPERATIONAL RESPONSIBILITIES OF THE *POWER SYSTEM CONTROLLER*

2.1 GENERAL RESPONSIBILITIES

The general responsibilities of the *Power System Controller* are:

(a) Ensuring the safety of personnel working on the *power system*; and

(b) Coordinating the *plant* maintenance programme.

2.2 *POWER SYSTEM SECURITY* RESPONSIBILITIES

The *power system security* responsibilities of the *Power System Controller* are set out in clause 3.3 and include:

(a) maintaining the continuity and security of electricity *supply*;

(b) *post-trip management* on *network* tripping or *generation* tripping;

(c) coordinating and sanctioning *plant outage* requests;

(d) regulating system *voltage*s to the required operation and performance standards;

(e) maintaining system *frequency* to the required operation and performance standards;

(f) controlling *system fault level* so as not to exceed the *plant* making capacity;

(g) arranging High Voltage *busbar* and feeder configurations for optimum system security;

(h) overseeing the operation of the *power systems* in accordance with the declared limits of the asset owners;

(i) reporting potential system problems;

(j) advising *System Participants* on abnormal incidents;

(k) designing under-*frequency load shedding* schedules and allocate *load* to each stage of the schedule;

(l) issuing major incidents reports;

(m) instigating post-mortem investigations of major *plant*/power failures; and

(n) developing Medium and Short Term *load* forecasts.

SECTION 3

3 *POWER SYSTEM SECURITY*

3.1 PURPOSE

This section:

(a) Provides the framework for achieving and maintaining a secure *power system*.

(b) Provides the conditions under which the *Power System Controller* can dispatch *generating units* and dispatchable *loads* and issue *directions* to *System Participants* so as to maintain or re-establish a secure and *reliable power system*.

(c) Has the following aims:

(1) to detail the principles and guidelines for achieving and maintaining *power system security*;

(2) to establish the processes for the assessment of the adequacy of *power system reserves*;

(3) to establish processes to enable the *Power System Controller* to plan and conduct operations within a *power system* to achieve and maintain *power system security*; and

(4) to establish processes for the actual dispatch of *scheduled generating units*, *semi-scheduled generating units*, scheduled *loads*, scheduled *network* services and *ancillary services* by the *Power System Controller*.

3.2 DEFINITIONS AND PRINCIPLES

3.2.1 *Power system*

(a) A *power system* is made up of the following *interconnected* components:

(1) *Generators*;

(2) *Loads*; and

(3) The *transmission* and distribution *networks* that *connect Generators* with *loads*.

3.2.2 High Voltage *network* components of a *power system*

The *Power System Controller* will adopt *reliability* criteria for *networks* to provide *reliability* performance for the *network* consistent with the security provisions contained in the *Network Technical Code* and Network Planning Criteria. These criteria are established with regard to the types of *Network Users* and the consequences of credible system contingencies.

3.2.3 *Generation* components of a *power system*

(a) Each *generating unit connected* to a *power system* is classified in accordance with the *Network Technical Code* and Network Planning Criteria as:

(1) a ~~Generation~~ *generating* *unit*;

(2) a ~~Small~~ small generator; or

(3) a small inverter energy system.

(b) Each *generating unit* shall be further classified by the *Power System Controller* as:

(1) a *scheduled generating unit*~~, if the output of the *generating unit* is capable of being varied to match the demand on the relevant *power system* in response to the requirements of the *Power System Controller*~~; or

~~(1)~~(2) *a semi-scheduled generating unit*, or

~~(2) a *semi-scheduled generating unit*, if the output of the *generating unit* is intermittent; or~~

(3) a *non-scheduled generating unit*~~, if the output of the *Generator* is not capable of being varied by in response to the requirements of the *Power System Controller*~~.

(c) The classification under clause 3.2.3(b) will be informed by the capability of the *generating unit* output to vary to match the demand on the relevant *power system* in response to the requirements of the *Power System Controller.*

Note: A A generating unit that achieves the capabilities specified in Version 4 of the Network Technical Code clauses 3.3.5.14 and 3.3.5.17 would have the capability referenced in clause 3.2.3 (c) of this code (SCTC) requiring the generating unit to be classified as a scheduled generating unit in accordance with 3.2.3 (b).

(d) Small g~~G~~enerators and small inverter energy systems shall be classified as a *non-scheduled* or *semi-scheduled generating unit*~~*Generators*~~.

~~(c)~~(e) The classification of a *generating unit* under clause 3.2.3(b) may change from time to time if there is a change in the capability of the relevant *generating unit.*

~~(d)~~(f) The *Power System Controller* will adopt *reliability* criteria for *generating plant* generally in accordance with the following:

(1) N-1, i.e. there is sufficient stand-by *plant* in a *power system* to cater for the loss of a single 'on line' *Generator*, though in many cases short periods of involuntary *load* shed may occur; and

(2) The *Power System Controller* will utilise available *spinning reserve* in the system, quick starting or stand-by *plant* to reconnect *customer*s and restore the relevant *power system* to normal, in accordance with the *ancillary services* procurement arrangements established in clause 5.1.

3.2.4 Electricity *supply reliability*

Electricity *supply reliability* is related not only to the availability of *generation* to meet the expected demand, but also to the readiness of sufficient responsive *supply reserves* to meet *credible contingency event*s.

Supply reliability in any *power system* is achieved through the continuous provision of:

(a) sufficient *supply* options available and in service to meet the forecast instantaneous *customer* demand for electricity;

(b) sufficient fast response *supply reserves* available either as unused *generating plant* actually in service (*spinning / regulating reserve*) or as *interruptible* *customer load* to cover a nominated level of impact resulting from a *credible contingency event*; and

(c) sufficient stand-by or short notice *supply reserve* to accommodate rapidly the impact of a *credible contingency event*, or to cope readily with multiple contingencies with a minimal period of disruption to *customer* demand.

3.2.5 *Power system reliability*

Power system reliability includes consideration of:

(a) Power *supply reliability* (*generation*):
This is the ability to meet demand and respond adequately to *supply* contingencies;

(1) availability of fuel *supply*;

(2) availability of *generating plant*; and

(3) availability of stand-by *plant*.

(b) Delivery system *reliability* (power *network*):
This is the ability of the *transmission system* to achieve the necessary transfer of electricity from the generating sources through the bulk delivery *substations* for distribution to consumers, and the ability to respond adequately to power *network* contingencies:

(1) adequate *transmission capacity* to meet reasonably foreseeable future *customer* demand;

(2) a *contingency* path to allow the credible *outage* of n-1; and

(3) *reactive power capability* to maintain stable system *voltage* levels and to cover contingencies and avoid *power system voltage* collapse.

(c) Fast acting *reactive plant* to act to stabilise the *transmission system voltage* levels in the event of a transient disruptive occurrence and so avoid the need for major *disconnection* or separation of impacted *regions* due to *voltage* instability or actual *voltage* collapse situations.

3.2.6 *Satisfactory operating state*

A *power system* is in a *satisfactory operating state* if all the following conditions apply:

(a) the *frequency* at all *energised busbars* of a *power system* is within the normal operating *frequency* range set out in the *Network Technical Code*, except for brief excursions outside the *normal operating frequency band* but within the abnormal operating *frequency* excursion band set out in the *Network Technical Code*;

(b) the *voltage* levels of all *energised busbars* at any switchyard or *substation* of a *power system* are within the relevant limits set out in the *Network Technical Code* or in any *connection* agreement with a *System Participant*;

(c) the current flows on all *transmission lines* and *equipment* of a *power system* are within the ratings (accounting for *time* dependency in the case of *emergency ratings*) provided by the *Network Operator*;

(d) the High Voltage *networks* are electrically *connected*;

(e) a *power system* is stable and in accordance with the *Secure System Guidelines* issued by the *Power System Controller* in accordance with clause 3.5; and

(f) the configuration of a *power system* is such that the severity of any potential fault is within the capability of circuit breakers to *disconnect* the faulted circuit or *equipment*.

3.2.7 Credible and *non-credible contingency event*s

(a) A *contingency event* means an event affecting a *power system* which the System Operator expects would be likely to involve the failure or removal from operational service of one or more *generating units*, *transmission* elements or *loads*.

(b) A *credible contingency event* means a *contingency event*, the occurrence of which the System Operator considers to be reasonably possible in the surrounding circumstances. Without limitation, examples of *credible contingency event*s are likely to include:

(1) the unexpected automatic or manual *disconnection* of, or the unplanned reduction in capacity of, one operating *generating unit*; or

(2) the unexpected *disconnection* of one major item of *transmission plant* (e.g. *transmission line*, *transformer* or *reactive plant*) other than as a result of a three phase electrical fault anywhere on a *power system*.

(c) A *non-credible contingency event* is a *contingency event* other than a *credible contingency event*. Without limitation, examples of *non-credible contingency event*s are likely to include:

(1) three phase electrical faults on a *power system*;

(2) certain *busbar* faults; or

(3) simultaneous disruptive events such as multiple *generating unit* failures; or double circuit *transmission line* failure (such as may be caused by tower collapse).

3.2.8 Re-classifying *contingency event*s

(a) Abnormal conditions are conditions posing added risks to the *power system* including, without limitation, severe weather conditions, lightning, storms and bush fires.

(b) The *Power System Controller* shall take all reasonable steps to ensure that it is promptly informed of abnormal conditions, and when abnormal conditions are known to exist shall:

(1) on a regular basis, make reasonable attempts to obtain all information relating to how the abnormal conditions may affect a *contingency event*; and

(2) identify any *non-credible contingency event* which is more likely to occur because of the existence of the abnormal conditions.

(c) As soon as practicable after the *Power System Controller* identifies a *non-credible contingency event* which is more likely to occur because of the existence of abnormal conditions, the *Power System Controller* shall provide *System Participants* with a notification specifying:

(1) the abnormal conditions; and

(2) the relevant *non-credible contingency event*.

(d) Whether the *Power System Controller* has reclassified this *non-credible* contingent event as a *credible contingency event* under clause 3.2.8(c), the

Power System Controller shall provide *System Participants* with a notification specifying:

(1) information (other than *confidential information*) in its possession that is relevant to its consideration under clause 3.2.8(c), the source of that information and the *time* that information was received or confirmed by the *Power System Controller*;

(2) the *time* at which the notification has been issued; and

(3) the *time* at which an updated notification is expected to be issued, where this might be necessary.

(e) The *Power System Controller* shall update a notification issued in accordance with clause 3.2.8(c) as it becomes aware of new information that is material to its consideration under clause 3.2.8(b), and in any event no later than the *time* indicated in the original notification under clause 3.2.8(d)(3), until such *time* as it issues a notification specifying that the abnormal conditions have ceased to have a material effect on the likely occurrence of the *non-credible contingency event*.

3.2.9 *Secure operating state*

A *power system* is in a *secure operating state* if in the reasonable opinion of the System Operator, taking into consideration the appropriate *power system security* and *reliability* principles described in clauses 3.2.10 and 3.2.11:

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

(b) the relevant *power system* will promptly return to a *satisfactory operating state* following the occurrence of any *credible contingency event* in accordance with the *Secure System Guidelines*.

3.2.10 General principles for maintaining *power system security*

(a) This includes consideration of the operational ability to ensure that *voltage* and *frequency* of a *power system* are maintained within limits, that a *power system* is able to withstand most single credible *supply* or delivery system *contingency* scenarios, without significant disruption of the *frequency* or *voltage*:

(1) that the relevant *power system* protection schemes are coordinated;

(2) that the appropriate operating safety margins are maintained; and

(3) that the relevant *power system voltage*s remain stable in the disruptions likely under the most *credible contingency* scenarios.

(b) The characteristic of a secure *power system* is essentially identified with the existence of stable *voltage*s and *frequency* throughout a *power system*.

(c) The *power system security* principles are as follows:

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

(2) Following a *contingency event* (whether or not a *credible contingency event*) or a significant *change* in *power system* conditions, the *Power System Controller* should take all reasonable actions to adjust, wherever possible, the operating conditions with a view to returning a *power system* to a *secure operating state* as soon as it is practical to do so, and, in any event, within thirty minutes.

(3) Adequate *load shedding* facilities initiated automatically by *frequency* conditions outside the normal operating *frequency* excursion band should

be available and in service to restore a *power system* to a *satisfactory operating state* following significant multiple *contingency events*.

(4) Sufficient system restart *ancillary services* should be available in accordance with the system restart standard to allow the restoration of *power system security* and any necessary restarting of *generating units* following a major *supply* disruption.

3.2.11 *Reliable operating state*

A *power system* is in a *reliable operating state* if in the reasonable opinion of the System Operator, taking into consideration the appropriate *power system security* principles described in clause 3.2.10:

(a) involuntary *load shedding* is not occurring;

(b) involuntary *load shedding* will not occur if a *credible contingency event* occurs; and

(c) the *energy* and capacity *reserve* criteria specified in the *Secure System Guidelines* are satisfied.

3.3 *POWER SYSTEM SECURITY* RESPONSIBILITIES AND OBLIGATIONS

3.3.1 Responsibilities of the *Power System Controller*

The *power system security* responsibilities of the *Power System Controller* are to:

(a) maintain *power system security*;

(b) monitor the operating status of a *power system*;

(c) co-ordinate *Network* operational personnel in undertaking certain activities and operations and monitoring activities of a *power system*;

(d) ensure that High Voltage switching procedures and arrangements are utilised by ~~the *Network*~~ *System Participants* to provide adequate protection of a *power system*;

(e) assess potential infringement of *Power System Operating Procedures* which could affect the security of a *power system*;

(f) ensure that all *plant* and *equipment* under its control or co-ordination is operated within the appropriate operational or *emergency* limits which are advised to the *Power System Controller* by the *Network Operator* or *System Participants*;

(g) assess the impacts of technical and any operational *plant* on the operation of a *power system*;

(h) arrange the dispatch of *scheduled generating units*, *semi-scheduled generating units*, scheduled *loads*, scheduled *network* services and *ancillary services* (including dispatch by remote control actions or specific *directions*) in accordance with the *Secure System Guidelines*;

(i) determine any potential *constraint* on the dispatch of *generating units*, *loads* and *ancillary services* and to assess the effect of this *constraint* on the maintenance of *power system security*;

(j) assess the availability and adequacy, including the dynamic response, of *contingency* capacity *reserves* and *reactive power reserves* in accordance with *power system security* and *reliability* standards and to ensure that appropriate levels of *contingency* capacity *reserves* and *reactive power reserves* are available to:

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

(2) arrest the impacts of a range of significant multiple *contingency event*s to allow a prompt restoration or recovery of *power system security*, taking into account under-*frequency* initiated *load shedding* capability provided under *connection* agreements or otherwise;

(k) determine the required levels of short term capacity *reserves* and medium term capacity *reserves* in accordance with *power system security* and *reliability* standards, and to assess the availability of the actual short term capacity *reserve* and actual medium term capacity *reserve* in accordance with the *Secure System Guidelines*;

(l) make available to *System Participants* 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*, and advise of any low *reserve* condition for the relevant periods where the short term capacity *reserve* and/or medium term capacity *reserve* is assessed as being less than that determined in accordance with the short term capacity *reserve* standard or medium term capacity *reserve* standard respectively;

(m) refer to *System Participant*s, as the *Power System Controller* deems appropriate, information of which the *Power System Controller* becomes aware in relation to significant risks to a *power system* where actions to achieve a resolution of those risks are outside the responsibility or control of the *Power System Controller*;

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

(o) procure adequate *black start capacity* in accordance with clause 5.7.1 to enable the *Power System Controller* to co-ordinate a response to a major *supply* disruption

(p) approve *Generators' Black System Procedures* in accordance with clause 5.7.2;

(q) develop a *Black System Restart Procedure* in accordance with clause 5.7.3;

(r) interrupt, subject to clause 6.21, *System Participant connections* as necessary during *emergency* situations to facilitate the re-establishment of the *satisfactory operating state* of a *power system*;

(s) issue a *direction* or instruction (as necessary) to any *System Participant*;

For the avoidance of doubt, the *Network Operator* as a *System Participant* shall have contractual arrangements in place to allow *directions* or instructions from the *Power System Controller* to be acted on by un-licenced *Network Users, and vice-versa,* in accordance with the mechanism specified in clause 3.3.3.

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

~~(t)~~(u) 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;

~~(u)~~(v) investigate and review all major *power system* operational incidents and to initiate action plans to manage any abnormal situations or significant deficiencies which could reasonably threaten *power system security*. 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;

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

~~(v)~~(w) ensure that the *Network Operator* satisfactorily interacts with the *Power System Controller* for both *transmission* and *distribution network* activities and operations, so that *power system security* is not jeopardised by *operations* on the *connected transmission networks* and *distribution networks.*

3.3.2 The *Power System Controller's* role in *power system security*

The *Power System Controller* will arrange the required *ancillary services* to maintain *power system security*:

(a) maintenance of an adequate *power system frequency*;

(b) maintaining *power system voltages* within the declared standards and limits;

(c) maintaining the stability of a *power system*;

(d) ensuring that under *credible contingency events*, that the components of a *power system* are not overloaded; and

(e) carrying out all appropriate actions to restore a *power system* to a secure condition following either a minor or major disruptive event.

To carry out these operational activities, particularly during periods when it is necessary to return a *power system* to a secure state following a disruption, the *Power System Controller* shall have all of the authority commensurate with the expectations of the *System Participants* to respond promptly, including the necessary indemnities.

3.3.3 Responsibility of the *Network Operator*

(a) The *Network Technical Code* sets out details of the technical requirements which the *Network Operator* shall satisfy as a condition of *connection* of any *plant* and *equipment* to a *power system*.

~~(a)~~(b) the *Network Operator* is to ensure that it has the rights prescribed in its *access agreements* with all un-licenced *Network Users* that permits the provisions in ~~clause 3.3.3(b)(2)~~the *Code* to be fulfilled by the relevant *Network User*, and in a time consistent with the urgency of the direction or request; and

(c) The *Network Operator*, in its role as a *System Participant*, shall respond to any *direction* or reasonable request of the *Power System Controller* issued in accordance with clause 3.3. In particular if that direction or request involves an action required to be performed by an un-licenced *Network User*, the *Network Operator* is to pass that direction on to ~~the~~ that *Network User*.~~:~~

~~the *Network Operator* is to ensure that it has the rights prescribed in its access agreements with all un-licenced *Network Users* that permits the provision in clause 3.3.3(b)(2) to be fulfilled by the relevant *Network User*, and in a time consistent with the urgency of the direction or request; and~~

~~if that direction or request involves an action required to be performed by an un-licenced *Network User*, the *Network Operator* is to pass that direction on to the that *Network User*.~~

(d) The *Network Operator*, in its role as *System Participant*, shall pass on to ~~one or more~~ un-licenced *Network Users* relevant information or reports on *power system* matters that it receives ~~is provided to it~~ from time to time from ~~by~~ the *Power System Controller*.

(e) The *Network Operator*, in its role as *System Participant*, shall inform the *Power System Controller* of nominated contact personnel from un-licenced *Network Users*, identified by the *Power System Controller*, for the purpose of giving or receiving *operational communications* in relation to its facilities.

(f) The *Network Operator*, in its role as *System Participant* and through ~~*the*~~ *access agreements*, shall oblige relevant un-licenced *Network Users* to comply with ~~establish~~ any operating protocol and arrangements ~~with the *Power System Controller*, as~~ determined from time to time by the *Power System Controller* in accordance with clause 1.7.4.

~~(b)~~(g) The *Network Operator* shall participate in any audit or investigation of system technical matters by the *Power System Controller*.

(h) The *Network Operator* shall rectify any technical non-compliance identified by the *Power System Controller* within the *time* specified by *the Power System Controller*.

Notes:

For the avoidance of doubt, the *Network User* will either be a licenced entity by virtue of clause 14 'Requirement for Licence' of the Electricity Reform Act (licenced *Network User*) or un-licenced (un-licenced *Network User*).

- A licenced *Network User* contributes to the pool of *System Participants* for the purpose of this *Code* and can be directed by the *System Controller* to take-action in regard to power system security matters.
- An un-licenced *Network User* will receive its directions from the *Network Operator* (who is also a *System Participant* for the purpose of this *Code*) in regard to *power system security* matters.

3.3.4 Responsibility of *System Participants*

(a) The *Network Technical Code* sets out details of the technical requirements which *System Participants* shall satisfy as a condition of *connection* of any *plant* and *equipment* to a *power system* (including *embedded generators* and embedded *customers*), except where specifically varied in an *access agreement*.

(b) *System Participants* shall respond to any *direction* or reasonable request of the *Power System Controller* issued in accordance with clause 3.3.

(c) *System Participants* shall participate in any audit or investigation of system technical matters by *Power System Controller*.

(d) A *System Participant* shall rectify any technical non-compliance identified by the *Power System Controller* within the *time* specified by *the Power System Controller*.

3.4 SYSTEM SECURITY CONSIDERATIONS

3.4.1 *Power system* instability

(a) The *transmission system* and the output of the rotating *generation plant* both have the potential to be disrupted by numerous events (e.g. *generating plant* faults, lightning, bush-fires, storms, high *voltage* switching, and *transmission equipment* faults).

(b) Each of the disruptions represents a potential transient instability situation for the *transmission* delivery system (resulting in *voltage*, *frequency* and potential *load* fluctuations).

(c) This is normally brought under control by fast-acting correction *equipment* (fault interruption protection, automatic *voltage* regulators, *generating plant* governors, stabilisers, *static VAR compensator*s, *automatic generation control*, *synchronous condensers*, etc.).

(d) Any situation which is not corrected quickly will normally result in automatic operation of generating or *transmission equipment* protection in an attempt to isolate the problem, but may also require intervention by the *Power System Controller* in an attempt to prevent further disruption or to correct the system condition.

(e) In a long *interconnected* alternating current *power system*, disruptions at one extremity of a power *network* can under some circumstances initiate power swings and associated *voltage* fluctuations at the other extremity of that *power system*.

(f) The fundamental responsibility of the *Power System Controller* is to provide *power system security* through actions to ensure that:

(1) an adequate *supply reserve* (spare *generation* or interruptible *load*) is maintained on a *power system* above the capacity required to meet the expected *customer* demand, and that the power *network* is considered to be able to withstand the disruption resulting from an unexpected *disconnection* of one *generating unit* or an item of *transmission equipment* due to the occurrence of a fault or for any other reason;

(2) satisfactory *voltage* levels, *frequency* levels and *reactive power reserves* are being maintained on the *transmission system*;

(3) the steady state stability of the power *network* is being maintained; and

(4) All *equipment* within the power *network* is being operated within acceptable ratings.

(g) The sudden failure or *forced outage* of any major single *power system* item such as a *Generator*, *transmission line*, *transformer*, etc. is known as a single *contingency event*. The *Power System Controller* will manage the relevant *power system* and *Generator* dispatch process such that, in the event of a single disruption:

(1) all *plant* and *equipment* would operate within ratings in a reasonable period following the initial transient impacts of the disruption;

(2) *customer load* would not be unnecessarily *disconnected*;

(3) the relevant *power system* would remain in synchronism;

(4) damping of any *power system* instabilities or oscillations would be adequate;

(5) *voltage control* criteria would be satisfied; and

(6) *frequency* control criteria would be satisfied.

3.4.2 Action to maintain *power system voltage* stability

(a) *Power system voltage* is impacted by sudden *change* of *reactive power* input or by *change* of a large reactive *load*. Such incidents include:

(1) the sudden loss of a *generating unit*;

(2) the interruption of a *transmission* circuit;

(3) the failure of a major *transmission transformer*; and

(4) the sudden increase of reactive *load*.

(b) There are specific dynamic devices installed within a *power system* to provide fast response to any *voltage* disturbance, by causing an adjustment in actual *reactive power* at appropriate locations within the relevant *power system*. Such devices include but are not limited to:

(1) SVCs (*Static VAR compensator*s);

(2) AVRs (Automatic *Voltage Control system*s, *Generator*);

(3) *synchronous condensers* with automatic *voltage control*; and

(4) *power system stabilisers* (increasing *Generator* AVR or SVC response during a *power system frequency* disturbance).

(c) A *power system* is considered to have undergone a "*voltage* instability" if the *voltage* level of a *power system* (or part of the relevant *power system*) cannot be returned to an acceptable operating level following a *power system* disturbance. This *voltage* collapse may be experienced locally or it may lead to a progressive collapse of *power system voltage*, possibly resulting in a total blackout.

(d) An under-*voltage* condition on a *power system* is a major threat to *power system* stability. Major *transmission* and distribution *transformer*s with automatic *voltage control system*s will invariably add to any *reactive power* deficiency by attempting to restore the sagging distribution *voltage*. Conditions may also be worsened if the generating sources of *reactive power* become limited by reaching a maximum *Generator* rotor current limit, removing their ability to respond to further *voltage* deficiencies.

(e) In extreme cases, a loss of synchronism can occur between remotely *connected* generating sources and a further worsening of *power system voltage* stability probably with accompanying power and *reactive power* swings between remote *generation* units. Unless the situation is recognised promptly and remedial action initiated, the extreme cases may result in a cascade effect potentially leading to a more extensive collapse of *power system voltage*.

(f) On recognising a *voltage* instability or potential *power system voltage* collapse condition, the *Power System Controller* may attempt to assist those devices by:

(1) providing active *reactive power* corrections by shedding of *customer loads* in the vicinity of the *voltage* disturbance;

(2) blocking of automatic on-*load transformer* tap changers to prevent further cascading *voltage* decay resulting from a reactive *supply* shortfall; or

(3) direct the *connection / disconnection* of *generating units*.

3.5 SECURE SYSTEM GUIDELINES

3.5.1 Issue of guidelines

The *Power System Controller* shall issue guidelines setting out the principles for determining:

(a) whether adequate *energy* and capacity *reserves* are being maintained on a *power system*;

(b) whether adequate *reactive power reserves* are being maintained on a *power system*;

(c) whether satisfactory *voltage* levels and *frequency* levels are being maintained on the High Voltage *network*s;

(d) the capacity of on-line *generating units* and *transmission* facilities required by a *power system* in order that it will withstand unexpected *disconnection* of *load* taking *System Participant*s; and

(e) whether a *power system* is stable.

3.5.2 Amendment of guidelines

The *Power System Controller* may amend, vary or replace the *Secure System Guidelines* at any time.

3.5.3 Requirement for consultation

The *Power System Controller* shall consult with *System Participants* before issuing, amending, varying or replacing *Secure System Guidelines*

3.5.4 Matters to be taken into account

In conducting the review and in subsequently amending, varying or replacing the *reserve* principles, the *Power System Controller* shall take into account the following matters:

(a) government policy;

(b) the *Power System Controller's* statutory obligations;

(c) historic levels of *reliability*; and

(d) costs and benefits.

3.5.5 The *Power System Controller* 's obligations

(a) Maintenance of a *secure system*:

(1) The *Power System Controller* shall endeavour to maintain a *secure system*.

(2) If a *power system* is no longer secure, then the *Power System Controller* shall minimise the risk to public safety and power supplies at points of *connection* to the High Voltage *network*s.

(b) Threat to *secure system*

If there is a threat to a *secure system*, threat to safety of persons or hazard to *equipment*, then the *Power System Controller* may take action to minimise the threat or hazard, including *disconnecting* a point of *connection* or taking High

Voltage *network equipment* out of service, or removal of *Generator/s* from service.

3.6 THREAT TO *SECURE SYSTEM* ADVICE

3.6.1 *System Participant's* advice

A *System Participant* shall promptly advise the *Power System Controller* after the *System Participant* becomes aware of any circumstance which could be expected to adversely affect the operation of a *power system* or the continuation of *secure system* state.

3.6.2 *The Power System Controller's* advice

The *Power System Controller* shall promptly advise any affected *System Participant* after the *Power System Controller* becomes aware of any circumstance with respect to a *power system* which could be expected to adversely affect *supply* of electricity to or from that *System Participant*.

3.6.3 Protection not available for service

Duplicate *protection systems* are specified for *transmission equipment* and *connections* on a *power system* in accordance with the requirements of the *Network Technical Code*.

(a) If:

(1) a *Generator* becomes aware that one of the major *protection systems* is not operating correctly or is unavailable for service; or

(2) a *Network Operator* or other *System Participant* becomes aware that one of the two primary *protection systems* relating to a *point of connection* to a *power system* is not operating correctly or is unavailable for service; or

(3) a *Network Operator* becomes aware that any of its High Voltage protection *equipment* relating to its High Voltage *network* is not operating correctly or is unavailable for service;

then the relevant *System Participant* shall promptly:

(4) notify the *Power System Controller* of that fact; and

(5) diligently restore the operation of the relevant *protection system* or put in place alternative protection.

(b) The *Power System Controller* in consultation with the *Network Operator* shall assess the risks to the continued operation of the relevant *power system* and determine the most appropriate course of action as set out in clause 6.7.1.

(c) Should the situation persist, the *Power System Controller* may direct that *equipment* be taken out of service and a *System Participant* shall comply with a *direction* given to it under this clause.

3.7 LACK OF *GENERATION* STAND-BY CONDITIONS

3.7.1 Declaration of lack of stand-by *generation* (LOS)

The *Power System Controller* shall assess the overall stand-by availability in the *power system*. The *Power System Controller* may declare lack of stand-by *generation* ("LOS") condition as follows:

(a) LOS1 may be declared when a *power system* is short of stand-by *generation plant* capacity up to an amount specified in the *Secure System Guidelines*, and the *Power System Controller* considers that there is a material risk of involuntary *load shedding* or the need to carry out *voltage* reduction following the Critical Credible *Contingency*;

(b) LOS2 may be declared when a *power system* is short of stand-by *generation plant* capacity up to an amount specified in the *Secure System Guidelines*, and the *Power System Controller* considers that there is a material risk of involuntary manual *load shedding* following the Critical Credible *Contingency*; and

(c) LOS3 may be declared when a *power system* is short of stand-by *generation plant* capacity in excess of an amount specified in the *Secure System Guidelines*, and the *Power System Controller* considers that there is a material risk of involuntary manual *load shedding* following the Critical Credible *Contingency*; and half-hourly rolling *outage*s are imminent.

3.7.2 Notice of LOS conditions

The *Power System Controller* shall advise *System Participants* of the estimated period of the LOS, and the estimated minimum Stand-by and its estimated *time* of occurrence, at the *time* the declaration is made.

3.8 FUEL SHORTFALL

3.8.1 Definition of fuel

In this clause fuel in relation to a *power station* means the primary *energy* sources of that *power station* (for example liquid fuel, gas).

3.8.2 *Generator* to notify

A *Generator* shall promptly notify the *Power System Controller* after it becomes aware that the accessible fuel for any of its *power station*s falls below the alert level.

3.8.3 Definition of alert level

The alert level in respect of a *power station* is such fuel as would enable all the *generating units* in the relevant *power station* to continue to generate at the *generated* output required in the currently applicable schedule instruction for the next

8 hours (or such shorter *time* period as is advised by the *Power System Controller* to the relevant *Generators* assuming that no further fuel becomes accessible to the *power station*.

Alert Levels are specified in the *Secure System Guidelines*.

3.8.4 14 *day* notice on fuel *supply outage*

For *planned outage*s affecting the primary fuel *supply* to a *power station*, 14 *day*s advanced notice is required.

3.9 SYSTEM *CONSTRAINT*

3.9.1 Generic system *constraint*

(a) Generic system *constraint* is an operator-applied function to declare a *power system* condition.

(b) Generic system *constraint*s are due to *transmission network outage*s, which result in *network* limitations.

(c) To avoid a generic system *constraint*, the *Power System Controller* will advise an appropriate *time* zone for a *network outage*. The decision will be based on system security and economic considerations.

3.9.2 *Network constraint*

(a) A *network constraint* is said to have occurred when a limit is required to be placed on the amount of *power flowing* through a defined element in the power *network*s.

(b) The majority of temporary *network constraint*s can be managed in the short term by *change* of *generation dispatch* mode or *network* re-configuration, including shift of normal-open points in the 11/22 kV system.

(c) Permanent *network constraints* are usually overcome by the augmentation of the *network* or *generating* capacity, where it is economic to do so.

3.10 *EMERGENCY* DEMAND REDUCTION (*LOAD SHEDDING*)

3.10.1 Involuntary *load shedding*

(a) *Generation dispatch* Policy

(1) Under normal operating conditions sufficient *generating plant* with adequate *regulating reserve* will be provided on line to meet system *load*.

(2) *Generators* have no obligation to keep any sort of *spinning reserve*

(3) Some *spinning reserve* may be available as a result of the difference between generating capacity on line and system demand.

(4) *Regulating reserve* is that capacity of a *generating unit* or units available to regulate *frequency* to within defined limits.

(5) *Generators* may *connect generating units* to the system for test run or any other purposes. The *Generator* shall give 24 hours notice to the *Power System Controller* of the impending *connection*.

(b) Under-*frequency Load shedding* (UFLS)

(1) The UFLS scheme is based on the accepted single *credible contingency* criterion.

(2) The scheme provides for different stages of UFLS that would cater for probable contingencies, short of a total loss of *generation* or *load*.

(3) Feeder/feeders selected on each stage should provide, continuously, a constant *load* to match the designed *load* shed quantity on that stage.

(4) The *Power System Controller* has the responsibility to allocate distribution feeders to UFLS and will consult with the relevant Retailers and *System Participants.*

(5) Feeders with important or essential *loads* attached are assigned to lower stages to avoid unnecessary interruption to these types of *customer*s.

(c) Manual *load shedding* by switching feeders

(1) Manual *load shedding* may be necessary if there is inadequate generating capacity within a *power system* and prior to stand-by *generation* units coming on line. The effect on system *frequency* may not warrant UFLS but the *Power System Controller* shall take action to prevent prolonged periods of low system *frequency*.

(2) The *Power System Controller* shall view Manual *load shedding* as a last resort.

(3) Manual *load* shed by *disconnection* of High Voltage feeders will be undertaken by the *Power System Controller* in a demonstrably equitable manner.

(d) Half-hour rolling *outage*s

(1) If *generation* capacity within a *power system* fails to meet the system *load* for a period exceeding 30 minutes, the *Power System Controller* may initiate half-hour rolling *outage*s on 11/22 kV feeders.

(2) Selected feeders will be switched out, in turn, for a period of 30 minutes each.

(e) Inadequate *power system generation*

The *Power System Controller* shall employ one or more of the above methods to reduce system demand when there is an unexpected shortfall of *generation*.

(f) Manual involuntary *load shedding*

The *Power System Controller* will continuously review the magnitude of *load shedding* requirements whilst manual involuntary *load shedding* is in progress.

(g) The *Network Operator* is responsible for the provision and maintenance of UFLS relays for interruptible High Voltage feeder circuits.

3.10.2 *Voltage* Reduction

(a) When the *generation* capacity fails to meet the system *load*, the *Power System Controller* may initiate *voltage* reduction at Zone *Substation* 11 or 22kV *busbars* (1% *voltage* Reduction will approximately result in 1% *Load*).

(b) *Voltage* reduction shall not exceed 4% of the *Voltage* Standard.

(c) Unless approved by the *Power System Controller*, each period of *voltage* reduction shall not exceed 30 minutes.

3.10.3 *Load* restoration after involuntary *load* shed

The *Power System Controller* shall ensure that *regulating reserve* is available to meet the system demand pick-up after *load shedding*.

3.11 ~~*LOAD*~~ FORECASTS

3.11.1 *System Participants* / *Customers* forecasts

System Participants shall provide the *Network Operator* and the *Power System Controller* information (including profiles and accuracy) relating to the *Network User*'s forecast for:

(a) *generation* capability for active power in the following format:

(1) a 30 day ahead forecast for capacity for every 30 minute interval updated daily~~as specified in the *Secure System Guidelines*;~~

~~(c)~~ (b) electricity *generation* or *load*.
(b)

3.11.2 Indicative medium, short term and daily *load* forecasts

The *Power System Controller* is responsible for producing indicative medium term, short term and daily *load* forecasts.

3.11.3 Methodology for *load* forecasts

The methodology for preparing the forecasts may include but is not limited to the following approaches:

(a) historic *day*;

(b) equivalent *day*;

(c) adjustment due to weather information provided by the Bureau of Meteorology;

(d) expected new *load connections* or growth in existing *loads*; and

(e) adjustment due to weather conditions in the *regions*

3.11.4 *Load* pattern *changes*

System Participants / Retailers shall advise the *Power System Controller* of any substantial *changes* in their *customer load* pattern or *load*ing behaviour, immediately such *changes* become apparent.

SECTION 4

4 *GENERATION* SCHEDULING

4.1 *REGULATING UNITS*

The *Power System Controller*, in consultation with the *power stations,* will appoint:

(a) (Deleted).

(b) One or more *generation* units as the *regulating units*.

(c) A *regulating unit* in a sub-system islanded from the *Grid*.

(d) In case of *emergency*, the *Power System Controller* will nominate a *power station* responsible for *frequency* control and maintain system *frequency* as detailed in clause 5.3 of this *Code*. The nominated *power station* shall comply with the instructions of the *Power System Controller*.

4.2 GOVERNOR CONTROL MODE

(a) The requirements for a *generating unit generation control system* are set out in the *Network Technical Code* and in the *access agreement* for the *Generator*.

(b) The normal mode of operation for the *governor system* of a *generating unit* is in 'droop' mode.

(c) The *access agreement* for the *Generator* may permit operation in 'block load' mode provided that it automatically *changes* to 'droop' mode if the *generating unit* is islanded from the *system*.

(d) A *Generator* shall advise the *Power System Controller* prior to a *generating unit* being operated in a mode where the *generating unit* will be unable to respond as specified in the *access agreement*.

(e) The *Power System Controller* will determine the *Generator's generation control* mode for *synchronised generating units* in all grid connected *power stations*.

4.3 DISPATCH

(a) Dispatch Principles include:

(1) system *reliability*;

(2) system security violations;

(3) ancillary problems;

(4) lack of *reserve;*

(5) *economic dispatch* (for the *Tennant Creek power system* and *Alice Springs power system*); ~~and~~

(6) *Security Constrained Economic Dispatch* (for the *Darwin-Katherine power system*); and~~.~~

~~(6)~~(7) where practicable, in normal operation, scheduling ancillary services from *generating systems* operated by Generators (other than Territory Generation) that pay for ancillary services under A6.11 should result in an equivalent or increased dispatch level (for the *Darwin-Katherine power system*).

(b) The *Power System Controller's SCADA system* will execute instructions for *Automatic Generation Control* (*AGC*) dispatch

(c) Dispatch criteria include:

(1) *power system security*;

(2) *frequency* Control and dispatch of *ancillary services*;

(3) *energy market* dispatch;

(4) (deleted);

(5) unplanned *generation* and *network outage*s;

(6) overall efficiency of *energy* production;

(7) minimum/maximum *load* limits of individual *generating unit*;

(8) rate of fast pick-up of individual *generating unit*; and

(9) *voltage* support.

(d) The *Power System Controller* will determine the setting of *frequency* bias;

(e) The *Power System Controller* may issue manual *dispatch instructions* to a *Generator*;

(f) Non-conforming *Generators*:
The *Power System Controller* will:

(1) monitor the performance of *Generators connected* to a *power system*;

(2) instruct a *Generator* to rectify the performance of the non-conforming *Generators*; and

(3) instruct a *Generator* to *disconnect* non-conforming *Generators* if the *Generator* fails to rectify the associated problems.

4.4 (Deleted)

(a) (Deleted).

(b) (Deleted).

(c) (Deleted).

4.4A MINIMUM *GENERATION* CAPACITY

(a) A *Generator* user must have sufficient generating capacity installed or contracted to meet its *Market Customers'* peak demand, which may include capacity provided via stand-by arrangements with other *Generators*.

(b) The *Generator* must comply with any guidelines developed and *published* by the Utilities Commission in *connection* with the assessment of whether a *Generator's* generating capacity is sufficient to meet the *Generator's* obligations under subclause (a).

(c) Any guidelines developed and published under subclause (b) must:

(1) take account of the impact on economic efficiency, and therefore have regard to factors including the efficient location of and level of overall capacity, *reserve* capacity and imbalance capacity on the system; and

(2) have regard to the efficient allocation of costs of capacity to different *customers* supplied by a power system.

(d) The Utilities Commission may review a *Generator's* actual generating capacity against the capacity required by compliance with the guidelines.

(e) If as the result of a review under subclause (d) the Utilities Commission considers that the *Generator*'s actual generating capacity is materially less than required by compliance with the guidelines, the *Generator* user must comply with any orders issued by the Utilities Commission aimed at ensuring compliance with the guidelines which may include, but are not limited to, procurement of contracts for anticipated demand, *reserve* and imbalance services to eliminate this deficiency.

(f) The Utilities Commission may require that a *Generator* furnish the *Power System Controller* in advance with satisfactory evidence that the user has contracted, or otherwise secured sufficient capacity, to the extent that this is required to assist the *Power System Controller* in the operation of a power system.

(g) The Utilities Commission may determine the form of the evidence required under subclause (f).

4.4B *GENERATION COMMITMENT AND DISPATCH SUBMISSIONS IN RESPECT OF THE DARWIN-KATHERINE POWER SYSTEM*

(a) This clause 4.4B applies only to the *Darwin-Katherine power system*.

(b) A *System Participant* being a *customer* or retailer of power shall ensure that its use of the *network* is in accord with the *access agreement*.

(c) *Generators* must make *commitment and dispatch submissions* in respect of *scheduled generating units* each *day* in accordance with the market timetable in a form, and containing the information, specified in a document published by the *Power System Controller* pursuant to subclause (e).

(d) *Commitment and dispatch submissions* must classify each *scheduled generating unit* as *self-committed* or *fast start* for the *trading day.*

(e) The *Power System Controller* may publish, and may amend from time to time by *publishing* a document specifying the form of, and information to be contained in, *commitment and dispatch submissions* in order to facilitate determination by the *Power System Controller* of the dispatch order in accordance with this *Code.* The *Power System Controller* must consult with *System Participants* prior to *publishing* such document. The form of, and information required to be contained in *commitment and dispatch submissions*, may differ as between *self-committed generating units* and *fast start generating units*, but must be reasonably required by the *Power System Controller* to determine the order of loading.

(f) Until such *time* as the *Power System Controller publishes* a document pursuant to subclause (d), *commitment and dispatch submissions* must contain the information and data described in Attachment 4.

(g) Subject to subclause (h), prices submitted in *commitment and dispatch submissions* must approximate:

(1) in respect of the dispatch of *self-committed generating units* above the minimum loading specified in the relevant submission; or

(2) in respect of the dispatch of *generating units* classified as *fast start*, the *dispatch cost* that would be incurred or avoided as appropriate by such dispatch.

(h) *Generators* must maintain a written record of the basis for the prices submitted in their *commitment and dispatch submissions* and provide this record to the Utilities Commission on request.

(i) In respect of *trading days* prior to 1 November 2015, *Generators* other than Territory Generation:

(1) may only classify *generating units* as *self-committed*, and

(2) in respect of capacity above minimum loading, must submit a price of zero.

4.4C LOAD FOLLOWING WITHIN TENNANT CREEK AND ALICE SPRINGS POWER SYSTEMS

(a) This clause 4.4C applies only to the Tennant Creek power system and the Alice Springs power system.

(a) A *Generator* shall follow the *load* of its *customer*s plus the *network losses*, after allowing for any transfer commitments to and/or from other *Generators*.

(b) A *System Participant* being a *customer* or retailer of power shall ensure that its use of the *network* is in accord with the *access agreement* and that *load* is balanced on all three phases.

(c) The *Power System Controller* shall procure sufficient 'last resort' source of provision of *energy* for the relevant *power system* in accordance with the *ancillary service* arrangements established in clause 5.1.

(d) To meet its obligations under subclause (b), a *Generator* must either:

(1) nominate a proportion of its *generation* capacity as being available to *supply load following services* to the relevant power system as a whole; or

(2) opt to provide its own *load* following services by using reasonable endeavours to ensure that its own use of the network is in balance.

(e) A *Generator* may alter its nomination under subclause (e)(1) with 30 *days*' notice to the *Power System Controller*.

(f) A *Generator* who nominates a proportion of its *generation* capacity to *supply load* following services to the relevant power system as a whole will be subject to *economic dispatch* arrangements developed by the *Power System Controller* as part of the *Code* and approved by the Utilities Commission.

(g) If the *Power System Controller* becomes aware that energy usage is out of balance by an amount that, in the *Power System Controller's* view, is likely to result in the operation of the relevant power system being materially affected or users being materially affected, the *Power System Controller* may interrupt or curtail the transfer of electricity to and from one or more *connection points* in respect of the associated *access agreement* in a manner consistent with efficient operation of the relevant power system in order to reduce that material adverse effect.

(h) If a *Generator's* available generating capacity during any *energy usage period* is shown to have been insufficient to meet its *customers*' *load* during that period, the *Generator* must reimburse the *Generator*, or *Generators*, responsible for supplying any balancing amount of generating capacity.

(i) The measurement of out of balance capacity, and any charges imposed on a *Generator* under subclause (h), are regulated by the provisions of Attachment 7 of this *Code*.

(j) A *Generator's* use of the *network* will be in balance under subclause (e)(2) if, after allowing for *network energy losses*, the quantity of *energy* at the *entry point* for the relevant *power system* by the *Generator* for each *energy usage* period is equal to the quantity of *energy* at the *exit point* of its *Customers* for that period.

(k) If a *Generator's energy* usage is shown to have been out of balance, and so has benefited from *load* following services provided by other Generators, that user must reimburse the *Generator* or *Generators* responsible for supplying the balancing amount of *energy*.

(l) The measurement of *out of balance energy*, and any charges imposed on a *Generator* under subclause (a) and subclause (i), are regulated by the provisions of Attachment 7 of this *Code*.

4.5 SYSTEM ISLANDING

(b) The *Power System Controller* shall maintain the *frequency* on islanded *region* and sub-systems in accordance with clause 4.3 of this *Code*.

(c) The *Power System Controller* shall correct the *time* error of an islanded system prior to re*connection* to the *Grid* System

(d) The *Power System Controller* shall reconnect islanded systems to the *Grid* System as practicable.

4.6 STAND-BY ARRANGEMENTS IN TENNANT CREEK AND ALICE SPRINGS POWER- SYSTEMS

(1) This clause 4.6 applies only in respect of the *Tennant Creek power system* and the *Alice Springs power system.*

(a) All *Generators* shall maintain stand-by *plant* available for immediate service in the event of a *single credible fault*, in accordance with the arrangements for the procurement of *ancillary services* in clause 5.1.

(b) *Generators* may satisfy this obligation to have immediately available stand-by *plant* by contracting for the necessary stand-by generating capacity with another *Generator.* Such agreements shall be lodged with *System Control.*

(c) Any such stand-by capacity agreement between *Generators* shall be subject to the approval of *Power System Control* and will be submitted to the *Power System Control* for this purpose.

(d) When a *Generator* becomes aware that an existing stand-by arrangement may terminate or suffer *changes* to stand-by capacity and availability, the *Generator* shall immediately notify *System Control* and provide details of alternative arrangements.

(e) All *Generators* shall advise *System Control* of their daily stand-by arrangements.

4.7 COMMITMENT AND DISPATCH ARRANGEMENTS FOR *I-NTEM* OPERATION

(a) This clause 4.7 applies only in respect of the *Darwin-Katherine power system*.

(b) A *Generator* must use reasonable endeavours to ensure that a *generating unit* classified as *self-committed* supplies the minimum loading submitted in the *commitment and dispatch submissions* unless the *Power System Controller* instructs that *Generator* not do so, in which case the *Generator* must use reasonable endeavours to ensure that the *generating unit* complies with the instruction.

(c) The *Power System Controller* must assess the need for:

(1) dispatch of *generating units* classified as *self-committed* above minimum loading; and

(2) *synchronisation* and dispatch of *generating units* classified as *fast start,*

in order to meet total demand and must determine an order of loading and issue *dispatch instructions* on the basis primarily of the principle of *Security Constrained Economic Dispatch* and the prices contained in the *commitment and dispatch submissions* and also having regard to the Dispatch Principles set out in clause 4.3(a), the Dispatch criteria set out in clause 4.3(c), other relevant information in the *commitment and dispatch submissions,* other relevant information regarding the operation of the *I-NTEM* and any other relevant provisions of this *Code*.

(d) A *Generator* must use reasonable endeavours to comply with a *dispatch instruction* issued to it by the *Power System Controller* unless to do so would, in the *Generator's* reasonable opinion be a hazard to public safety or materially risk damaging *equipment*.

4.8 INTERIM *ENERGY MARKET PRICE*

(a) This clause 4.8 applies only in respect of the *Darwin-Katherine power system*.

(b) The *Market Price Principle* is that the *Market Price* for each *trading interval* represents the marginal value of *supply* to balance *supply* and demand in accordance with the principle of *Security Constrained Economic Dispatch.*

(c) The *Power System Controller* may *publish*, and may amend from time to time by *publishing* a document specifying the methodology by which the *Market Price* is to be determined to give effect to the *Market Price Principle.* The *Power System Controller* must consult with *System Participants* prior to *publishing* such document.

(d) Until such *time* as the *Power System Controller publishes* a document pursuant to subclause (b) the *Market Price* must be determined in accordance with the methodology set out in Attachment 5.

(e) The *Power System Controller* must use its reasonable endeavours to determine the *Market Price* for each *trading interval* of the previous *trading day(s)* as soon as reasonably practicable but no later than 1500 hours the following *business day*.

(f) If the *Power System Controller* fails to determine the *Market Price* for a *day* by 1500 hours in accordance with this clause it must *publish* the reason it was unable to do so and determine the *Market Price* for relevant *trading day(s)* as soon as reasonably possible.

SECTION 5

5 *ANCILLARY SERVICES*

The *Power System Controller* may instruct *System Participants* to provide one or more of the following *ancillary services* within the declared operating limits of their *plant connected* to the *Grid* System. Nothing in this section 5 limits the ability of the *Power System Controller* to determine an order of loading and issue *dispatch instructions* in accordance with clause 4.7.

The *System Participants* may be remunerated for provision of *ancillary services* based on type and amount of service provided.

5.1 ARRANGEMENTS FOR THE PROCUREMENT OF *ANCILLARY SERVICES*

The *Power System Controller* shall develop a regulatory mechanism for the procurement and responsibility for *ancillary services*, including:

(a) *voltage control* services;

(b) *frequency* control services; and

(c) black start services.

In developing the regulatory mechanism for the procurement of *ancillary services*, the *Power System Controller* shall consult with relevant *System Participants* and the Utilities Commission.

5.2 CONTROL OF *NETWORK VOLTAGE*S

5.2.1 Explanation

The continuous transfer of electrical power is facilitated by the level and the stability of the *transmission system voltage*, which is effectively established by the *supplying generating plant* and controlled through the adjustment of the *reactive power flow*s through the various parts of the *transmission system*. This control, initiated by the detection of *power system voltage* variations, adjusts *Generator* magnetic field currents via an automatic *voltage* regulator, or *connects* / *disconnects* capacitors or *reactor*s to alter *power system* impedance, or adjusts *transformer* variable winding ratios (tap changers), and thus the *transmission voltage* conditions at key locations within the *transmission system*.

The loss or disruption of *power system voltage* has a major impact on the ability of the *transmission system* to transfer power to the *distribution system*.

5.2.2 *Voltage control* - *Network Operator* / *Power System Controller*

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

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

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

(d) The *Power System Controller* shall maintain *voltage* conditions throughout the *network* in accordance with the technical requirements specified in the *Network Technical Code*.

(e) The *Network Operator* shall arrange the provision of *reactive power* facilities and *power system voltage* stabilising facilities in the Power *Network*s through:

(1) obligations on the part of *Network Users*; or under their *access agreement*s; and

(2) the provision of such facilities by the *Network Operator*.

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

(1) *synchronous Generator voltage control*s usually associated with tap-changing *transformer*s; or *Generator* AVR set point control (rotor current adjustment);

(2) *synchronous condensers* (compensators);

(3) *static VAR compensator*s (SVC);

(4) shunt capacitors;

(5) shunt *reactor*s; and

(6) series capacitors.

5.2.3 *Reactive power reserve* requirements

(a) The *Power System Controller* shall ensure that sufficient *reactive power reserve* is available at all times to maintain or restore a *power system* to a *satisfactory operating state* after the most critical *credible contingency event* as determined by previous analysis or by periodic *contingency* analysis by the *Network Operator*.

(b) If *voltage*s are outside acceptable limits, and the means of *voltage control* set out in this clause are exhausted, the *Power System Controller* shall take actions to restore the *voltage*s to within the relevant limits. Such action may include:

(1) direct *System Participants* to reduce demand through selective *load shedding* from the relevant *power system*;

(2) direct *Generators* to provide additional capacity on line; and

(3) direct a *Network Operator* to restore a *transmission line* which has been taken out of service.

(c) *System Participants* shall comply with any such *direction* or immediately advise the *Power System Controller* if it is not possible to follow the *direction*.

5.2.4 *Generating unit*s *reactive power* output

(a) Each *generating unit* shall be capable of *supplying reactive power* at the *generating unit* terminals at nominal *voltage*.

(b) Lagging *power factor* capability shall be no less than the limit specified in the *Network Technical Code* or as specified in the relevant *access agreement*.

(c) Leading *power factor* capability shall be no less than the limit specified in the *Network Technical Code* or as specified in the relevant *access agreement*.

(d) *Generators* are required to comply with the *Power System Controller* instructions to regulate their *reactive power* output for *power system* requirements.

(e) During substantial fluctuation of *power system voltage*, *Generators* shall not attempt to adjust field current or *transformer* taps unless otherwise instructed by the *Power System Controller*.

(f) If a *generating unit* c*hanges voltage* regulation mode, such as from 'automatic' to 'manual' control or an alternate AVR is brought into service; or if any over-excitation limiter or under-excitation limiter has operated, the *Generator* shall immediately inform the *Power System Controller* of this *change* and any known consequences thereof.

(g) If any *scheduled generating unit* is operating beyond the values specified in the *Secure System Guidelines* for lack of *reactive power reserve*, the *Generator* shall immediately inform the *Power System Controller*.

5.2.5 Audit and testing

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

5.3 *FREQUENCY* CONTROL AND *FREQUENCY* OPERATING STANDARDS

5.3.1 *Power System Controller* objectives in relation to *frequency*

The *Power System Controller* shall endeavour to:

(a) Maintain the *power system* within the relevant *normal operating frequency band* set out in the *Network Technical Code*.

(b) Ensure *regulating reserves* are such that normal *load* variations do not result in *frequency* deviations outside the limitations specified in clause 5.3.1(a).

(c) Restore *power system frequency* within the *normal operating frequency band* in the event of:

(1) a large sudden & unplanned *change* in the system *load*;

(2) unplanned *disconnection* of a *generating unit*; or

(3) unplanned occurrence of a *single credible fault*.

(d) in relation to clause 5.3.1(c), the *Power System Controller* may shed *load* to aid recovery of *frequency* to within the *abnormal frequency band* set out in the *Network Technical Code*. The *Power System Controller* may then restore *power system frequency* to within the *normal operating frequency band*.

(e) No action is necessary to correct *power system frequency* if the deviation from target is within +/- 0.05 Hz.

5.3.2 Intervention to maintain *power system frequency*

(a) Occasionally the *Power System Controller* may be required to exercise judgement during major abnormalities as a result of contingencies which create a *supply* shortage. Some of these actions may interrupt *supply* to some *customers*.

(b) Following such contingencies and remedial actions it is possible that a *power system* could fail to be maintained in a secure condition in the event of the next single *contingency*. In these circumstances the *Power System Controller* shall take immediate action to modify *power system* conditions to return the system to a *secure operating state*.

5.3.3 *Frequency* indicates power *supply* adequacy

Whilst all system parameters are important, *frequency* is the most significant indicator of the overall operational adequacy of a *power system*.

5.4 *SCADA* COMPUTER *TIME SYNCHRONISING*

(a) All *power station* computer *time* shall be *synchronised* with the Standard *Time*, as determined by the *Power System Controller*. *Time synchronised* to GPS systems is considered acceptable.

(b) All clocks shall be confirmed to be *synchronised* with the *Power System Controller SCADA* clock on the first working *day* of each *month*.

5.5 ELECTRIC *TIME* ERROR CONTROL

(a) The limit of electric *time* error is +/- 15 seconds.

(b) No action is necessary to correct the *time* error if it is less than +/- 2 seconds.

(c) The *Power System Controller* shall endeavour to maintain system *time* error to within the standard limits.

5.6 *NETWORK LOAD*ING CONTROL

(a) The *Power System Controller* is responsible for monitoring the *network* loading and for reporting to the asset owner any impending loading and security problems on the power *network*s due to excessive *network* usage.

(b) The *Network Operator* shall assess and determine the limits of the operation of the *network* and associated *equipment*.

(c) The limits of operation of the *network* and associated *equipment* shall be determined by the *Network Operator* for the security and *reliability* of the assets. Such limits may include, but are not restricted to:

  (1) nominal thermal limits;

  (2) nominal maximum *current rating*;

  (3) cyclic thermal rating;

  (4) 30 minutes *emergency rating*; and

  (5) de-rating factors for multiple cables in the same cable trench.

5.7 *BLACK SYSTEM*

5.7.1 *Black start power station*

The *Power System Controller* will designate *power station*s that have *black start capacity* as black start *power station*s.

(a) The *Power System Controller* may advise a *Generator* with *black start capacity* if a *black system* is imminent.

(b) If the *Power System Controller* advises a *Generator* to take action for black start, then the *Generator* shall comply with the requirements of the relevant *Black System Procedures*.

5.7.2 *Black System Procedures*

(a) A *Generator* shall develop a draft *Black System Procedure* for each of its *power stations.*

(b) *Black System Procedures* shall detail the step by step functions to be carried out by the *Generator* as well as the corresponding instructions from the *Power System Controller* in the event of a *black system*.

(c) *Generators' Black System Procedures* shall be:

(1) submitted by the *Generator* to the *Power System Controller* ; and

(2) approved by the *Power System Controller*.

(d) At any time, the *Power System Controller* may request amendments to the *Black System Procedures*.

(e) If a *Generator* disagrees with an amendment requested by the *Power System Controller* then it may so notify the *Power System Controller* and the parties shall promptly meet and attempt to resolve the disagreement. In the event that there is failure to resolve the disagreement, the matter shall be referred to the Utilities Commission for resolution.

(f) A *Generator* shall be deemed to have agreed to an amendment to *Black System Procedures* unless giving notice to the contrary to the *Power System Controller* within 20 *Business day*s of receiving the amendment notice from the *Power System Controller*.

(g) A *Generator* shall review *Black System Procedures* for each of its *power station*s at least once every three years.

(h) A *Generator* may propose *change*s to *Black System Procedures* for one or more of its *power station*s by notice in writing to the *Power System Controller*.

5.7.3 *Black System Restart Procedure*

(a) The *Power System Controller* shall develop a *Black System Restart Procedure* for each of the regulated *power systems*.

(b) *The Black System Restart Procedure* shall incorporate the relevant *Generator black start* procedures and is designed to restart and restore a *power system* so as to minimise disruption to *System Participants.*

(c) The *Power System Controller* shall review the *Black System Restart Procedure*:

(1) by 31 October each year;

(2) when the availability of a *Generator* may be affected for an extended period; or

(3) if a *Generator* proposes a *change* to its *Black* Start Procedure in accordance with clause 5.7.2(h).

5.7.4 Actual *black system*

(a) Throughout *Black System Procedures*, a *Generator* or the *Network Operator* shall observe all Safety Procedure requirements and maintain close contact with the *Power System Controller*.

(b) The *Power System Controller* will be responsible for every step of High Voltage switching and *Generator synchronisation*.

(c) If there is a *black system*, a *System Participant* shall comply with any and all instruction given to it by the *Power System Controller* with respect to the timing and magnitude of *load* restoration.

5.8 *ENERGY BALANCING* IN THE *TENNANT CREEK* AND *ALICE SPRINGS POWER SYSTEMS ONLY*

This clause 5.8 applies only in respect of the *Tennant Creek power system* and the *Alice Springs power system*.

5.8.1 Obligation of the *Network User*

A *Network User* shall ensure that, for each *energy usage period* of use of the *network*:

(a) the input to the *power system* is equal to the quantity of electrical *energy* used, plus

(b) the *network energy losses* expected between the *entry points* and *exit points.*

5.8.2 Role of -the *Power System Controller*

The *Power System Controller* shall:

(a) Monitor a *Network User*'s *energy* usage.

(b) Establish a methodology to determine the amount of out-of-balance *energy* supplied by a *Generator*.

(c) Monitor the bidding process for the *economic dispatch* of *out of balance energy* service for each of the *energy usage period*.

(d) Undertake the settlement of the resultant charges between *Generators*.

(e) Impose charges on the *generator* user relating to that imbalance in order to reimburse the *Generator*, which is responsible for *supplying* the balancing amount of electricity.

(f) If a *Generator* is out of balance by an amount that, in the *Power System Controller's* view, is likely to affect the operation of a *power system*, the *Power System Controller* may interrupt or curtail the transfer of electricity to and from one or more *connection points* in respect of the associated *access agreement* in order to reduce that material adverse effect.

(g) If no *Generator* bids for the *out of balance energy* service, the *Power System Controller* may give *direction* to a *Generator* to provide the *out of balance energy*.

5.8.3 *Network energy loss factor*

(a) The *energy loss factor* for a *connection point,* which is a point at which electricity is transferred between differently owned and operated electricity *network*s or between *transmission* and *distribution system*s within an electricity *network*, is a factor determined by the *network* provider for specific transfer locations.

(b) The *Network Operator* shall determine the *energy loss factors* between the *entry point* and *exit point* of a *Network User*.

5.9 *ECONOMIC DISPATCH* FOR *ENERGY BALANCING* IN THE *TENNANT CREEK* AND *ALICE SPRINGS POWER SYSTEMS*

5.9.1 Scope of clause

This clause 5.9 applies only in respect of the *Tennant Creek power system* and the *Alice Springs power system*.

5.9.1 *Load* following duty

Generators on *load* following duty are deemed to be instructed to provide the out of balance capacity and *energy*.

5.9.2 Buy and sell bids

Generators will provide “sell” and “buy” bids at every *energy usage period* for the provision of *out of balance energy*. The *frequency* control service provider will also provide “buy” and “sell” bids for each *energy usage period*.

5.9.3 System Control overview

While *Generators* bid freely to provide the *out of balance energy*, the *Power System Controller* will oversee and ensure the bid prices of the *Frequency* Control Ancillary Service provider are fair and equitable, especially in a two *Generator* scenario.

5.9.4 Market status

The *Power System Controller* will declare the status of the market for every *energy usage period*:

(a) <u>Over-supplied market</u>: A market situation when the *Generators* are producing more *energy* than the market requires, and the *frequency* control service provider has to pull back in production.

(b) <u>Under-supplied market</u>: A market situation when the *Generators* are producing less *energy* than the market requires, and the *frequency* control service provider has to increase in production.

5.9.5 *Out of balance energy* prices

(a) *Over supplied market*: the *energy* price will be the lowest bid of the “buy” prices of *Generators* that are importing for that *energy usage period*.

(b) *Under supplied market*: the *energy* price will be the highest bid of “sell” prices of *Generators* that are exporting for that *energy usage period*.

5.9.6 *Out of balance energy* settlement

(a) The *Power System Controller* will advise the relevant *Generators* of the daily *out of balance energy* transactions.

(b) The *Power System Controller* will advise the relevant *Generators* of the *monthly out of balance energy* transactions.

5.10 (Deleted)

5.11 *SYSTEM PARTICIPANT* INFORMATION

(a) This clause 5.11 applies only to the *Darwin-Katherine power system*

(b) The *Power System Controller* must, from a date as soon as practicable after the commencement of the *I-NTEM*, provide to relevant *system participants*:

(1) By 1600 hours on a *business day*, at least 72 hours ahead of the *trading day*:

(i) Forecast total system demand for each half hour for the *trading day.*

(2) As soon as reasonably possible in the *day* ahead of the *trading day*:

(i) Pre-dispatch targets and pre-dispatch clearing prices for the *trading day.*

(c) The *Power System Controller* must provide to the *Market Operator* for *publication*:

(1) The *Market Price* for each half hour of the previous *trading day* calculated pursuant to clause 4.8(e).

(2) From a date as soon as practicable after the commencement of the *I-NTEM*:

(i) the *pre-dispatch schedule* for the *trading day*.

(ii) the actual dispatch schedule for the *trading day*.

(iii) the actual *constraints* for each *trading interval* in the *trading day*.

(iv) the total system demand for each *trading interval* in the *trading day*.

SECTION 6

6 *POWER SYSTEM* OPERATIONS

6.1 CONTENTS

Power System Operating Procedures include:

(a) basic electrical safety requirements;

(b) electrical safety instructions;

(c) general operating/field procedures; and

(d) station-specific procedures related to the operation of a *power system* in that station.

The *Power System Controller* is responsible for short-term operation planning to achieve system security and stability and to ensure the system is operating in an efficient manner.

6.2 *PLANT* INFORMATION AND OPERATIONAL DATA

System Participants shall lodge a set of the *plant* information and operational data of their *equipment* with the *Power System Controller* in accordance with the requirements and *time* frame set out in the *Network Technical Code*.

6.3 OPERATION AND SAFETY PROCEDURES MANUAL: NT OPERATING & SAFETY INSTRUCTION MANUAL (GREEN BOOK)

The Operating & Safety Instruction Manual is managed by the *Network Operator*.

As soon as practical after becoming aware of an amendment to the Operating & Safety Instruction Manual (Green Book), the *Network Operator* shall advise the *Power System Controller* and other *System Participants* of such *change*s.

6.4 APPROVAL OF PERSONNEL

6.4.1 Authorised officers:

Each electricity entity holding a current market license may nominate Authorised Officers in accordance with the Electricity Reform Act Part 6.

6.4.2 Electricity officers

Each electricity entity holding a current market license may nominate Electricity Officers in accordance with the Electricity Reform Act Part 4.

6.4.3 *Registered operators*

(a) A *System Participant* shall maintain a register of individuals authorised to undertake electrical operations at the interface with a High Voltage *network* or on a High Voltage *network*, and provide this maintained list to the *Power Systems Controller*.

(b) A *System Participant* shall ensure that electrical operations performed on its behalf at the interface in the *power system* are undertaken only by *Registered Operators*. The *Power System Controller* may confirm by random audit that such electrical operations are undertaken by *Registered Operators*.

(c) If a *Registered Operator* fails to comply with the Green Book and the relevant operating procedures the *Power System Controller* may instruct a *System Participant* to delete that individual's name from the register or refuse to allow that individual's name in the register. The *Power System Controller* shall promptly notify the relevant *System Participant*, giving reasons for taking such action.

(d) A de-*registered operator*, following re-training, counselling or re-familiarisation, may re-apply for assessment of Authorisation and registration.

6.5 *PLANT OUTAGE* PROCEDURES

6.5.1 Types of *outages*

The following outage types may be identified by a *System Participant* or where relevant the *Power System Controller*.

(a) Scheduled *outages* (statutory or required by manufacturer).

(b) *Planned outages* (non-urgent work which may wait for an arranged *outage time* - the condition of the *plant* does not have significant impact on system security).

(c) *Forced outages* (tripped or switched out).

~~(c)~~(d) *Performance issue outages* (work required by the *Power System Controller* or *System Participant* to address issues that impact on *secure system* operation).

6.5.2 Application for *plant outages*

Applicants shall advise the *Power System Controller* of:

(a) specify type of work;

(b) *plant / equipment* affected;

(c) duration of *outage*;

(d) declare a *recall time* of *outages*, if applicable;

(e) give 10 working *days*' notice for any impending *planned outage* requests; and

(f) an estimation of the revised restoration *time* if the *outage* is overrun by a significant amount of *time*.

6.6 *FORCED OUTAGES* AND *PERFORMANCE ISSUE OUTAGES*

The *Power System Controller* has the following responsibilities concerning *forced outages* and *performance issue outages*:

(a) maintenance of system stability;

(b) restoration of system *frequency* and *voltages*;

(c) restoration of system security;

(d) to ensure availability of *generation*; and

(e) restoration of service to *customers*.

6.7 PROTECTION MAINTENANCE

6.7.1 Partial failure or unavailability of *protection systems*

Where there is a failure of one protection of a *network* element, the *Power System Controller* in consultation with the *Network Operator* shall determine the most appropriate action. Depending on the circumstances the determination may be:

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

(b) to take the *network* element out of service immediately;

(c) to install or direct the installation of a temporary protection;

(d) to accept a degraded performance from the protection, with or without additional operational measures or temporary protection measures to minimise *power system* impact; or

(e) to operate the *network* element at a lower capacity.

6.7.2 Complete failure or unavailability of *protection systems*

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

(b) Any affected *System Participants* shall accept a determination made by the *Power System Controller*.

6.7.3 Protection maintenance with the circuit *energised*

The *Power System Controller* may accept risk of tripping and approve maintenance work on one of the protection schemes on a piece of *equipment* with the circuit *energised*. Such approval will depend upon system conditions and risk assessment.

6.7.4 Protocols for protection or control system abnormality

Where an operating protocol is required to be developed, it must contain arrangements for informing relevant parties, including mitigating actions, when any *protection system* or *control system* becomes defective or unavailable for service and where it may have an impact on power system security.

6.8 OTHER *EQUIPMENT* OPERATIONS

6.8.1 *Automatic reclose equipment*

(a) A *Network Operator* may from time to time request that the *Power System Controller* disable *automatic reclose equipment* in relation to a particular feeder which has *automatic reclose equipment* installed on it.

(b) If a *Network Operator* makes a request under clause 6.8.1 (a), then The *Power System Controller* shall comply with the request.

(c) The *Power System Controller* and the relevant *Network Operator* are not responsible for the consequences of automatic re-closure in relation to a Feeder, except if the *Power System Controller* has not complied with a request under clause 6.8.1(a).

(d) Where *automatic reclose equipment* is installed on a High Voltage feeder that *connects* an *embedded generator*, the *Network Operator* shall ensure that the relevant *embedded generator* is *disconnected* from the relevant *power system* prior to the re-close proceeding.

6.8.2 System neutral earthing

(a) No part or section of the system shall be operated without a neutral earth *connection*.

(b) If High Voltage *equipment* loses its neutral earthing:

(1) de-*energise* the *equipment* / system immediately; and

(2) take action to restore the *connection*.

(3) Clauses 6.8.2(a) and (b) do not apply to the delta *connected* windings of *generating units* which may not be effectively earthed.

6.8.3 *Plant unit protection* operations

The *equipment* shall not be *energised* unless:

(a) The *equipment* is checked and inspected by an Authorised technical officer; and

(b) The *Power System Controller* approves the re-*energisation* of the *equipment*.

6.9 *TIME* CONSIDERATIONS

Due to system security considerations, the *Power System Controller* may recommend *plant outage times*:

(a) *Time* Zones

(1) Red Zone: 0730-1730 ~~hrs~~ hours

(2) Yellow Zone: 0600-0729 hrs 1731-2000 ~~hrs~~hours

(3) Green Zone: 2001-0559 ~~hrs~~hours.

(b) *Time* of *plant outages*

Depending on nature of work, impact on system security and the consequences of a possible second *contingency*, the *Power System Controller* shall determine the *time* of *plant outages*.

6.10 ANNUAL *PLANT* MAINTENANCE FORECAST

6.10.1 *Generators*

On or before 15 May each year, each *Generator* shall submit to the *Power System Controller* for each of its *generating units*:

(a) a maintenance programme for the relevant unit for the following *financial year*, and

(b) an indicative maintenance programme for the relevant unit for each of the 3 *financial years* following the *financial year* to which the maintenance programme submitted under paragraph (a) relates.

6.10.2 *Network Operator*s

On or before 15 May each year, each *Network Operator* shall submit to the *Power System Controller*:

(a) a maintenance programme for its *transmission* and High Voltage *networks* for the following *financial year*; and

(b) an indicative maintenance programme for each of the 3 subsequent *financial year*s.

6.10.3 *Power System Controller* response

The *Power System Controller* shall respond to all submissions within 30 *day*s.

6.11 COMMISSIONING / REPLACEMENT OF *PLANT*

System Participants shall refer to and act in accordance with the requirements of the *Network Technical Code*.

6.12 COMMUNICATION FACILITIES ~~-~~ – *POWER SYSTEM CONTROLLER*

(a) Each *System Participant* shall provide, for each nominated contact, two independent communication systems fully compatible with the *equipment* installed at the *Power System Controller*.

(b) Each *System Participant* shall provide two speech communication facilities and shall investigate faults within 2 hours of a fault being identified and shall immediately effect repair.

(c) The *Power System Controller* and a *Network Operator*, High Voltage Consumer or *Generator* shall establish and maintain a form of electronic mail facility for communication purposes.

6.12.1 Speech communication channels to the *Power System Controller*

(a) PABX through switchboard.

(b) Direct lines.

(c) Satellite phones.

(d) Radio (HF, VHF, UHF etc.).

6.12.2 Operational speech communication discipline

(a) The receiver of the message shall repeat the operation instruction to the sender (this applies both to the *Power System Controller* and field personnel).

(b) Receiver/Caller identification:

~~e.g.~~ for example "Car 45 (receiver) ~~-~~ – *Power System Controller* (caller)".

6.12.3 Records of speech *operational communication*s

(a) Voice recordings of telephone or radio *operational communications* may be undertaken by the *Power System Controller*. The *Power System Controller* shall ensure that, when a telephone or radio conversation is being recorded under this clause, the persons having the conversation receive an audible indication that the conversation is being recorded.

(b) The *Power System Controller* may also record all speech *operational communications* in the form of logbook entries.

(c) All *Registered Operators* shall record all speech *operational communications* in the form of log book entries.

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

(e) The *Power System Controller* shall retain all *operational communications* records (including tapes of voice recordings) for a minimum of ~~7~~ seven years.

(f) As part of a dispute resolution process, a *System Participant* may inspect the *Power System Controller* records of speech *operational communications* between the *Power System Controller* and that *System Participant* during normal business hours and may make copies or extracts of those records. A *System Participant* shall give the *Power System Controller* reasonable notice of its intention to inspect records under this clause.

6.13 TOTAL LOSS OF COMMUNICATIONS TO THE *POWER SYSTEM CONTROLLER*

(a) Every effort shall be made to restore some form of communication.

(b) In case of a *power station*, the local staff shall nominate a *Registered Operator* in charge of station *frequency*, circuit *loading*, and *voltage* and system stability.

(c) The nominated *Registered Operator* shall give instructions normally given by the *Power System Controller*. All switching and other system operations are logged and shall be reported to the *Power System Controller* when communications are restored.

(d) During this period of *time*, observations of, and adherence to, the Green Book directives are of paramount importance.

6.14 *PLANT* NUMBERING, *NOMENCLATURE* AND DRAWINGS

Subject to paragraph (l), t~~T~~he standards approved by the *Network Operator* and endorsed by the *Power System Controller* relating to numbering, terminology and abbreviations used for information transfer by *System Participants* and *Network Users* are to be formed and applied by the relevant parties in accordance with the following principles:

(a) The standards are to be used when conveying information on the *power system* between all *System Participants* and *Network Users*.

(b) The *Network Operator* shall establish the *nomenclature standards* for *network* equipment.

(c) A *Network User* shall use the *nomenclature standards* for *network* equipment and apparatus as agreed with the *Network Operator* or failing agreement, as determined by the *Network Operator*.

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

(e) A *Network User* shall ensure that name plates on its equipment relevant to operations at any point within the *power system* conform to the requirements set out in the *nomenclature standards*.

(f) A *Network User* shall use reasonable endeavours to ensure that nameplates on its equipment relevant to operations within the power system are maintained to ensure easy and accurate identification of equipment.

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

(h) All *nomenclature* shall be unique, uniform and unambiguous.

(i) The *Network Operator* is responsible for the making any changes to enable all *nomenclature* to be unique, uniform and unambiguous.

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

(k) *System Participants* shall lodge with the *Power System Controller,* a copy of the one-line-diagram of their system.

~~(a)~~(l) A *Generator* who has been granted a relevant derogation under clause 12.1 of the *Network Technical Code* is not required to change the nomenclature of existing plant to conform with the principles in paragraphs (a) to (k), unless the *Network Operator* requests the change, and agrees to bear the associated costs. However, that *Generator* must conform with the above principles for any new plant that is connected to the power system.

~~(b) All *plant* numbers shall be unique.~~

~~All *plant nomenclature* shall be consistent.~~

6.15 *EMBEDDED GENERATORS* IN *CUSTOMERS'* PREMISES

(a) A Retailer shall advise the *Power System Controller* of the details of *embedded generators* in the premises of *customer*s.

(b) The Retailer shall specify if the *embedded generator* is capable of parallel operation with a *power system*.

(c) The *Network Operator* will set the requirements for safe parallel operation or impose the interlocking requirements to prevent parallel operation with a *power system*.

6.16 EMBEDDED *CUSTOMER*S

Embedded *customer*s of a *Generator* will be tripped with the *Generator*, unless special arrangements having prior approval of the *Power System Controller* are in place.

6.17 REVENUE METERING

In respect of the *Tennant Creek power system* and the *Alice Springs power system*, the *Network Operator* or the metering service provider is responsible for forwarding interval or consumption data from metering used for revenue, tariffs or other purposes to the *Power System Controller* for *energy balancing*.

6.18 *REMOTE MONITORING* AND REMOTE CONTROL

(a) *System Participants* shall provide the *Power System Controller* with the remote control and monitoring information on their *equipment* status, alarm and measure values via communication links to the *Power System Controller SCADA system* as specified in the *Network Technical Code* or an *access agreement*.

(b) The *Network Technical Code* sets out details of the technical requirements which *System Participants* shall satisfy as a condition of *connection* of any *plant* and *equipment* to a *power system*.

(c) The *Power System Controller* shall advise the standard alarm and control point names of the *SCADA system*.

(d) *System Participants* shall advise the *Power System Controller* of the analogue alarm settings of their *equipment* for *SCADA* alarm processing purposes. The *Power System Controller* may request special alarm setting for system requirements

(e) *System Participants* shall test and calibrate the analogue transducers every 3 years.

(f) *If a System Participant* or the *Power System Controller* becomes aware that any *remote monitoring* or remote control point *equipment* is defective:

(1) the *System Participant* shall respond to the *remote monitoring* point defect immediately;

(2) if the nature of the defect is such that it cannot be repaired within 3 *days*, the *System Participant* shall develop a plan to rectify the defect and submit the plan to the *Power System Controller* for approval; and

(3) if the nature of the defect is such that the safety or security of a *power system* would be jeopardised by the *remote monitoring* or control defect the *Power System Controller* shall take whatever action is necessary, including removing the *System Participant's equipment* from service.

6.19 *PLANT* ROUTINE TESTS

(a) Any *plant* routine tests that may affect *power system security* or output of *generation* shall have prior approval of the *Power System Controller*.

(b) Requests for such tests shall be submitted to the *Power System Controller* with ~~5~~ five working ~~*days* notice~~ *days*' notice.

6.20 ACCESS TO UNMANNED HIGH VOLTAGE *SUBSTATION*S AND *POWER STATION*S

(a) *System Participants* shall advise the *Network Operator* on entry and exit of unmanned High Voltage *substation*s or *power station*s.

(b) The *Network Operator* shall log such entry and exit on the logbook.

6.21 DIS*CONNECTION* FROM THE SYSTEM

6.21.1 Voluntary *disconnection*

(a) Unless agreed otherwise and specified in an *access agreement*, a *System Participant* shall give to the *Network Operator* notice in writing of its intention to permanently *disconnect* a *facility* from a *connection* point.

(b) A *System Participant* shall provide a minimum of 30 ~~*days* notice~~*days'* notice of intention to permanently *disconnect* a *facility* unless a shorter period is specified in an *access agreement*.

(c) A *System Participant* is entitled, subject to the terms of the relevant *access agreement*, to require voluntary permanent *disconnection* of its *equipment* from a *power system* in which case appropriate operating procedures necessary to ensure that the *disconnection* will not pose a threat to *power system security* shall be implemented.

(d) The *System Participant* shall pay all costs directly attributable to the voluntary *disconnection* and *decommission*ing.

6.21.2 *Decommission*ing procedures

(a) In the event that a *System Participant's facility* is to be permanently *disconnected* from a *power system*, the *Network Operator*, the *System Participant* and the *Power System Controller* shall, prior to such *disconnection* occurring, follow agreed procedures for *disconnection*.

(b) The *Network Operator* shall notify the *Power System Controller* and relevant *System Participants* if it considers that the terms and conditions of an *access agreement* will be affected by procedures for *disconnection* or proposed procedures agreed with any other *System Participant*. The parties shall negotiate any amendments to the procedures for *disconnection* or to the *access agreement* that may be required.

(c) Any properly agreed *disconnection* procedures shall be followed by all *System Participant*s.

6.21.3 Involuntary *disconnection*

The *Network Operator* or the *Power System Controller* may *disconnect* a *System Participant's* facilities from a *network*:

(a) during an *emergency*;

(b) in accordance with relevant laws; and

(c) in accordance with the provisions of the *System Participant's access agreement*.

In all cases of *disconnection* by the *Power System Controller* during an *emergency*, the *Power System Controller* is required to undertake a review and shall then provide a report to the *System Participant* advising the circumstances requiring such action.

6.21.4 Dis*connection* due to breach of an *access agreement* or threat to system security

(a) The *Power System Controller* may request the *Network Operator* to *disconnect* the *System Participant's* facilities which may, in the view of the *Power System Controller,* pose a threat to the system security if the facilities continue to operate and *connect* to a *power system*.

(b) In such circumstances the *Power System Controller* will not be liable in any way for any loss or damage suffered or incurred by the *System Participant* by reason of the *disconnection*.

(c) A *System Participant* shall not bring proceedings against the *Power System Controller* to seek to recover any amount for any loss or damage described in this clause.

(d) A *System Participant* whose facilities have been *disconnected* under this *Code* shall pay charges set in accordance with the ~~Network Pricing and Charges Schedule pursuant to the Network Access Code~~*NT NER*.

6.21.5 Disconnection during an *emergency*

Where the *Power System Controller* may *disconnect* a *System Participant's* facilities during an *emergency*, then the *Power System Controller* may:

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

(b) Immediately *disconnect* the *System Participant's* facilities by automatic or manual means where, it is not appropriate to follow the normal procedure 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*.

During multiple system contingencies (beyond the normal standards for *power system security*), the *Power System Controller* shall take whatever anticipatory or restorative action is necessary to balance electricity *supply* and demand, and ultimately to protect the integrity of a *power system*. Such action may include the shedding or *disconnection* of a *customer*'s *load* and the introduction of power rationing.

The *Power System Controller* will try to maintain or shift *customer*s' *load* if possible.

6.22 AUDITING AND INSPECTION OF TECHNICAL REQUIREMENTS

6.22.1 Requirement for technical audit and inspection

(a) The security, *reliability* and *quality of supply* to all *System Participants* requires that all *Network* and *System Participant equipment* meet and maintain the technical requirements set out in the *Network Technical Code*.

(b) The *Power System Controller* shall be responsible for establishing a Schedule of Audit and Inspection of *Network* and *System Participant equipment* to ensure that the *equipment* meets and maintains the technical requirements and specifications set out in the *Network Technical Code*.

(c) The Schedule of Audit and Inspection shall be established with regard to:

(1) the security implications of the *Network* or *System Participant equipment* being non-compliant;

(2) the economic consequence of the *Network* or *System Participant equipment* being non-compliant; and

(3) the likelihood that the *Network* or *System Participant equipment* is non-compliant.

(d) The *Power System Controller* shall develop an initial Schedule of Audit and Inspection by 1 July 2012.

(e) The *Power System Controller* shall reissue the Schedule of Audit and Inspection by 1 July each year.

(f) The *Power System Controller* shall issue the Schedule of Audit and Inspection to the Participants whose *equipment* is involved.

(g) The *Power System Controller* shall arrange audit and inspection activities in accordance with the Audit and Inspection Schedule.

6.22.2 Requirement to participate in technical audit

(a) The *Network Operator* and *System Participants* shall be obliged to permit the audit and inspection of their *equipment* in accordance with the Schedule of Audit and Inspection.

(b) *System Participants* shall not unreasonably refuse access to *equipment* or records by the *Power System Controller* for the purpose of audit and inspection under clause 6.22.1.

6.23 ACCESS FOR INSPECTION AND TESTING

If the *Power System Controller* considers that a *System Participant* is not complying with a provision of this *Code*, the *Power System Controller* may request the *Network Operator* to inspect the relevant *facility* and the operation and maintenance of that *facility* in order to assess compliance by the relevant *System Participant* with its obligations under *Network Technical Code*.

6.24 *GENERATOR* CAPABILITY PERFORMANCE

(a) Consistent with the *Network Technical Code*, each *Generator* shall periodically perform tests to confirm *scheduled generating unit* performance capabilities for each and every *scheduled generating unit*. Each *Generator* shall be responsible for all costs associated with performance capability verification.

(b) The nature and periodicity of such tests shall be determined by the *Power System Controller* in consultation with the *Generator*, and recorded in the participant-specific (ring-fenced) components of the *Secure System Guidelines*.

(c) Actual performance of the tests shall be negotiated and coordinated with the *Power System Controller* and subject to appropriate *power system security* considerations.

(d) The results of all such tests shall be the basis for provision and/or amendment of Performance Capability Information, to the *Network Operator* and the *Power System Controller* and recorded in the Participant-specific (ring-fenced) components of the *Secure System Guidelines*.

(e) Performance Capability Information shall be reviewed and updated by the *Generator* as detailed below:

(1) All information – on any major *change* of *plant* or subsystem or *control system* or algorithm, or on direct request by the *Power System Controller*;

(2) Information specifically required to achieve the outcomes identified in this *Code* – at least annually;

(3) Information specifically required to achieve the outcomes identified in the *Secure System Guidelines* – at least annually;

(4) Type R2 data as defined in the *Network Technical Code* – every 4 years; and

(5) Other information as required by the *Power System Controller* on a case by case basis (to allow for differing technologies, age of *plant*, or other unique characteristics) – as defined by the *Power System Controller*.

(f) Each *Generator* shall take all reasonable endeavours to ensure the performance of *scheduled generating units* meets the latest Performance Capability Information provided to the *Power System Controller*.

(g) Each *Generator* shall immediately advise the *Power System Controller* of amended Performance Capability Information as soon as they become aware of a situation or circumstance that will result in a *change* to notified Performance Capability Information.

(h) The *Power System Controller* may request that a *Generator* review and amend Performance Capability Information if the *Power System Controller* believes that the *plant* does not meet the notified Capability Information. The *Generator* shall respond promptly with amended Capability data.

SECTION 7

7 *POWER SYSTEM* INCIDENT REPORTING PROCEDURES

7.1 CONTENTS

Power system incident reporting procedures include:

(a) investigation and reporting process;

(b) the *Power System Controller*'s obligation to investigate and report on incidents; and

(c) role of the Utilities Commission.

7.2 INVESTIGATION AND REPORTING ON *REPORTABLE INCIDENTS*

(a) Each *System Participant* shall provide a written report on *reportable incidents* to the *Power System Controller* within ~~7~~ seven working *day*s. When there is no clear finding of cause of fault, an interim report may be acceptable.

(b) The *Power System Controller* will issue official reports on *major reportable incidents* and will distribute such reports to relevant *System Participant*s.

(c) The *Power System Controller* may request, and *System Participants* shall comply and provide accurate and complete information associated with *reportable incidents*.

(d) The *Power System Controller* will investigate and report on *reportable incidents* according to these incident reporting procedures.

(e) The *Power System Controller* is to be guided by *good electricity industry practice* for ensuring a *power system* operates reliably, safely and securely, in determining if an event is a *reportable incident* requiring an investigation.

7.3 THRESHOLDS FOR *REPORTABLE INCIDENTS*

7.3.1 *Reportable incident*

A *reportable incident* is a *power system* event that had, or could have had, a significant adverse effect on security or *reliability* of electricity *supply*, due to an event affecting:

(a) the *energy* production capability or capacity of electricity *generation* assets; or

(b) the *energy* transport capability or capacity of the electricity *transmission* and distribution *network*s assets.

7.3.2 *Major reportable incident*

A *major reportable incident* includes an event that caused:

(a) loss of *load* arising from a failure of a *generation* asset;

(b) loss of *load* arising from a failure of a *transmission* asset (or equivalent) of more than 0.1 system minute, excluding any incident where *load* is shed as agreed by contract;

(c) an *outage* lasting longer than 15 minutes arising from *equipment* failure or operator error in a zone *substation*;

(d) an *outage* lasting longer than ~~6~~ six hours affecting more than 200 *customer*s and that, in the opinion of the *Power System Controller*, should be classified as a major incident requiring comprehensive investigation; or

(e) an *outage* lasting longer than 30 minutes affecting more than 1000 *customer*s and that, in the opinion the *Power System Controller*, should be classified as a major incident requiring comprehensive investigation.

7.3.3 *Minor reportable incident*

A *minor reportable incident* includes an event that caused:

(a) an *outage* lasting longer than ~~6~~ six hours affecting more than 200 *customer*s and that, in the opinion of the *Power System Controller*, can be classified as a minor incident; or

(b) an *outage* lasting longer than 30 minutes affecting more than 1000 *customer*s and that, in the opinion of the *Power System Controller*, can be classified as a minor incident.

7.3.4 Incident reporting guideline

Subject to this provision, the *Power System Controller* ~~may~~ shall develop and maintain a guideline describing criteria for classifying events as *reportable incidents* (the Incident Reporting Guideline).

In developing a guideline describing *reportable incidents*, the *Power System Controller* shall take into account *good electricity industry practice*.

7.4 INVESTIGATION AND REPORTING PROCESS

The *Power System Controller* shall conduct a review and report on every reportable operating incident 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* or electricity *supply*.

The *Power System Controller* is to be guided by *good electricity industry practice* for investigating and reporting on *reportable incidents*, including in regard to the level of investigation appropriate to the consequences or potential consequences of an incident.

Subject to the requirements of this *Code*, the *Power System Controller* may develop and maintain a guideline describing the investigation and reporting process.

7.4.1 Notification of a *reportable incident*

The *Power System Controller* is to advise relevant *System Participants* and the Utilities Commission as soon as reasonably practical after the event occurred that an event was a *reportable incident*, and that an investigation will be conducted.

The form and manner of the notification of a *reportable incident* is to be determined by the *Power System Controller* in accordance with any conditions specified in the Incident Reporting Guideline.

7.4.2 Reporting by a *System Participant*

System Participants are to advise the *Power System Controller* as soon as reasonably practical after an event, where there is potential for that event to be classified as a *reportable incident*.

Relevant *System Participants* should provide a written report, with detail appropriate to the consequences or potential consequences of an incident, to the *Power System Controller* on an event and incident within ~~7~~ seven working *days* or as soon as reasonably practical after receipt of notification of a *reportable incident* by the *Power System Controller*.

A *System Participant* should provide an interim written report when there is no clear finding of cause of fault and an investigation is ongoing.

7.4.3 Initial report by the *Power System Controller*

The *Power System Controller* is to provide the Utilities Commission with an initial report within 14 working *days* of a *reportable incident*, containing key details of the event and incident, and the scope of the investigation.

7.4.4 Final report by the *Power System Controller*

The *Power System Controller* is to provide a *major reportable incident* investigation report to *System Participants* and the Utilities Commission as soon as reasonably practical after the event occurred.

The *Power System Controller* is to report on *minor reportable incidents* in its half yearly reports to the Utilities Commission.

Information included in reports on *reportable incidents* by the *Power System Controller* and *System Participants* should reflect *good electricity industry practice* and should include such minimum information as the *Power System Controller* may specify in a Guideline.

7.5 PUBLIC REPORTING

(a) Nothing in this *Code* prevents the *publication* of a public report by the *Power System Controller* or by the Utilities Commission.

~~(a)~~(b) The *Power System Controller* shall include in the Incident Reporting Guidelines provisions for advising un-licenced *Network Users* of *power system* incidents where they are affected or potentially affected by *power system emergency* conditions.

7.6 INDEPENDENT INVESTIGATION OF A *REPORTABLE INCIDENT*

The Utilities Commission may direct the *Power System Controller* to engage an independent expert to undertake an investigation and prepare the final report.

The terms of reference for the independent investigation will be developed by the *Power System Controller*, and approved by the Utilities Commission.

The *Power System Controller* and *System Participants* will cooperate with, and provide all necessary information to the independent expert.

The cost of the independent investigation will be met by the *Power System Controller.*

SECTION 8

8 OTHER MATTERS

8.1 COMMUNICATIONS WITH THE *POWER SYSTEM CONTROLLER*

8.1.1 Communications directed to the *Power System Controller* in relation to this *Code*

(a) Communications shall be in writing, shall be marked for the attention of the *Power System Controller* at the stated address and may be:

(1) delivered and left at that address;

(2) sent by prepaid ordinary post to that address;

(3) sent by facsimile to the facsimile number of the addressee; or

(4) sent by Electronic Mail Facilities to the electronic mail address of the addressee.

(b) Any person or organisation to which this *Code* applies shall notify the *Power System Controller* of its address, facsimile number, electronic mail address and telephone number for the purposes of Communications under this *Code* immediately after:

(1) this *Code* first becomes applicable to it; or

(2) any *change* to the address, facsimile number, electronic mails address or telephone number previously notified under this clause.

8.1.2 Communication issued by the *Power System Controller* in relation to this *Code*: (Advice of the *Power System Controller*'s Address)

The *Power System Controller* shall, by notice in writing, advise all *System Participants* of details:

(a) postal address;

(b) facsimile numbers;

(c) electronic mail addresses;

(d) telephone numbers; and

(e) other related addresses where applicable, immediately following the acquisition of an address or a *change* to an existing address.

8.2 *OPERATIONAL COMMUNICATIONS*

8.2.1 Communication from the *Power System Controller* to a *System Participant* in relation to a particular *facility*

(a) If in writing, the communication shall be:

(1) marked to the attention of one of the *System Participant's* nominated contact personnel, or

(2) to the facsimile number of the *System Participant* or sent by Electronic Mail Facilities to the electronic mail address of the *System Participant*.

(b) if by telephone, the communication shall be:

(1) a conversation with one of the *System Participant's* nominated contact personnel; and

(2) on one of *System Participant's* advised telephone numbers.

8.2.2 Communication from a *System Participant* to the *Power System Controller* in relation to a particular *facility*

(a) If in writing, the communication shall be:

(1) marked to the attention of one of the *Power System Controller* nominated contact personnel, or

(2) to the facsimile number of the *Power System Controller* or sent by Electronic Mail Facilities to the electronic mail address of the *Power System Controller*.

(b) If by telephone, the communication shall be:

(1) a conversation with one of the *Power System Controller* nominated contact personnel; and

(2) on one of the *Power System Controller's* advised telephones.

8.2.3 *System Participant's* nominated contact personnel -– the *Power System Controller* to be advised

(a) Each *System Participant* shall advise the *Power System Controller* of nominated contact personnel (identified by title) for the purposes of giving or receiving *operational communications* in relation to each of the *System Participant's* facilities.

(b) Personnel so nominated shall be those responsible for undertaking the operation of the *System Participant's equipment*.

(c) The required details of nominated contact personnel are:

(1) the title of each nominated contact personnel;

(2) the telephone numbers of the communications systems in relation to the relevant *facility*;

(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*.

8.2.4 The *Power System Controller* nominated contact personnel -– *System Participants* to be advised

(a) The *Power System Controller* shall advise all *System Participants* of nominated contact personnel (identified by title) for the purposes of giving or receiving *operational communications* by the *Power System Controller*.

(b) The details to be provided are:

(1) The title of each nominated contact person;

(2) the telephone numbers of the *Power System Controller*;

(3) a facsimile number for the *Power System Controller*; and

(4) an electronic mail address for the *Power System Controller*.

8.2.5 Communications to take effect

A communication shall take effect as from:

(a) the *time* that the communication was actually received (or is taken to have been received); or

(b) any later *time* specified in the communication (provided it was actually received prior to that *time*).

8.2.6 Confirmation of receipt of communications – Responsibility of originator / issuer of the communication.

(a) Urgent and/or specific *facility* related communications

Originators/ issuers/senders of urgent and/or specific *facility* related communications shall contact the intended recipient of communications and shall request confirmation that the recipient has received the subject communication.

(b) Routine communications

Originators/ issuers/senders of more routine communications may accept as record of dispatch and receipt of communications:

(1) facsimile machine reports showing satisfactory dispatch to facsimile numbers of intended recipients; or

(2) electronic mail reports showing satisfactory dispatch to electronic mail addresses of intended recipients.

8.3 *DIRECTION*S ISSUED BY THE *POWER SYSTEM CONTROLLER* (*SYSTEM PARTICIPANTS* FAILURE TO RESPOND)

(a) If *System Participants* fail to respond to a request by the *Power System Controller* on matters concerning:

(1) non-conformance with the Codes;

(2) (Deleted);

(3) *transmission equipment* fails to return to service without reasonable explanations;

(4) violations of *power system security*;

(5) persistently low capacity of stand-by *plant* or absence thereof; or

(6) other relevant non-conformance which may affect *power system security* and stability.

The *Power System Controller* will then issue a *Direction* to the *System Participant* requesting immediate response with advice of compliance.

(b) *System Participants* shall immediately respond to that *Direction*.

8.4 *POWER SYSTEM CONTROLLER* REPORTS

The *Power System Controller* shall report on the following operational matters:

(a) new *System Participants* and the relevant installations;

(b) system security problems;

(c) system black;

(d) excess use of *Network*;

(e) loss of *generation*/major *transmission line*s;

(f) under-*frequency load shedding*; and

(g) lack of *Reserve*/low in *Reserve*.

8.4.1 Half yearly report to the Utilities Commission

The *Power System Controller* shall submit a half yearly Report to the Utilities Commission setting out the performance and *reportable incidents* of the *power system*. The report will be issued on or before 31 January and 31 July each year.

8.4.2 Quarterly report to *System Participant*s

The *Power System Controller* shall make available to *System Participants* a report setting out the performance and major incidents of the *System Participant* and other major incidents related to the *System Participant*. The report will be issued on or before 31 July, 31 October, 31 January and 30 April each year.

8.4.3 Annual reports

The *Power System Controller* shall contribute as resources allow and as requested by the *System Participants* in relation to information for Annual Reports.

8.5 *POWER SYSTEM CONTROLLER* REQUESTS FOR OPERATION AND PERFORMANCE INFORMATION

(a) The *Power System Controller* may require operation and performance information from *System Participants* in order to carry out duties outlined in the System Control Licence.

(b) *System Participants* shall immediately respond and provide the necessary information.

(c) The *Power System Controller* shall ensure that *confidential information* is not inadvertently provided to other irrelevant *System Participants* or to the public.

8.6 *POWER SYSTEM CONTROLLER* CHARGES FOR SERVICES

(a) The *Power System Controller* services attract charges which shall be recovered from *System Participants* in receipt of those services.

(b) The charge will be recovered as a “Postage Stamp Amount” applied to all *energy* transfers in the relevant *power system*.

(c) The charge is based on the *revenue energy meter*s of *customer*s and is as approved by the Utilities Commission.

(d) The charge shall be paid *month*ly.

ATTACHMENT 1 GLOSSARY OF TERMS OF THE *CODE*

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

Access agreement	Means an ~~contract or~~ agreement for the provision of *network* access services entered into between a *Network Operator* and a *Network User* whether under the *NT NER*, the former Network Access Code or otherwise~~Electricity Network (Third Party Access) Act and its associated Code, and includes an award made by an arbitrator for the same purpose~~.
Alice Springs power system	The *power system* located in the *region* of Alice Springs operated pursuant to licences issued by the Utilities Commission pursuant to Part 3 of the Electricity Reform Act.
Ancillary services	Refers to the following services provided by *Generators* or other *System Participants*: *voltage control*, *reactive power* control, *frequency* control, and *black start* capability.
Automatic generation control*, *generation control*, *AGC	A *generating unit* which responds to the regulating signals from the *Power System Controller SCADA* computing system.
Automatic reclose equipment	In relation to a power line, the *equipment* which automatically recloses the relevant line's circuit breaker(s) following their opening as a result of the detection of a fault in the power line.
Black start capacity	In relation to a *generating unit*, the ability to start and *synchronise* without using *supply* from a *power system*.
Black system	The absence of *voltage* on all or a significant part of the *network* following a major *supply* disruption, affecting one or more *power stations* and a significant number of *customers*.
Black System Procedures	The procedures, described under clause 5.7.2 applicable to a *Network User* or a *Generator* as procedures approved by the *Power System Controller* from time to time.
Black System Restart Procedures	The procedures described in clause 5.7.3 developed by the *Power System Controller* for the restart of a *power system* following a *black system*.
Busbar	A common *connection point* in a *power station substation* or a *transmission network substation*.
Business day	Any *day* other than a Saturday, Sunday, or *day* that is a public holiday in the City of Darwin.
Capacitor bank	A type of static electrical *equipment* used to generate *reactive power* and therefore support *voltage* levels on *network* elements.
Change	Includes amendment, alteration, addition or deletion.
***Code*~~, *Technical Code*~~**	This~~ *Code*, also called the *Technical Code*~~ System Control Technical Code, prepared under clause 38(1) of the Electricity Reform Act ~~.~~

Commitment and dispatch submission	A notice submitted by a *Generator* to the *Power System Controller* relating to the dispatch of a *scheduled generating unit* in accordance with the requirements of clause~~s [~~4.4B.~~(d)] and [4.4B(e)~~©~~].~~
Confidential information	In relation to a *Market Participant,* or the *Power System Controller*, information which is or has been provided to that *Market Participant* or *Power System Controller* under or in *connection* with the *Code* and which is stated under the *Code* or by *Power System Controller* or by the *Utilities Commission* to be *confidential information* or is otherwise confidential or commercially sensitive. It also includes any information which is derived from such information.
Connect, connected, connection	Means to establish an effective link via installation of the necessary connection equipment.
connection point	The point of *supply* between a *Network Operator* and a *Network User*.
Constraint*, *constrained	A limitation on the capability of a *network*, *load* or a *generating unit* preventing it from transferring, consuming or generating the level of electrical power which would otherwise be available if the limitation was removed.
Contingency	*Disconnection* or separation, planned or forced, of one or more components from the *power system*
Contingency event	An event affecting a *power system* which the *Power System Controller* expects would be likely to involve the failure or removal from operational service of a *generating unit* or *network* element as defined in clause 3.2.7.
Control system	Means of monitoring and controlling the operation of the *power system* or *equipment* including *generating units connected* to a *network*.
Credible contingency event	A *contingency event*, the occurrence of which the *Power System Controller* considers to be reasonably possible as defined in clause 3.2.7.
Current rating	The maximum current that may be permitted to flow (under defined conditions) through a power line or other item of *equipment* that forms part of a *power system*.
Customer	A person who purchases electricity supplied through a *network*.
Darwin-Katherine power system	The *power system* located in, and between, the *regions* of Darwin and Katherine operated pursuant to licences issued by the Utilities Commission pursuant to Part 3 of the Electricity Reform Act*.*
Day	Unless otherwise specified, the 24 hour period beginning and ending at midnight Australian Central Standard Time.
Decommission	In respect of a *generating unit*, ceasing to generate and *disconnecting* from a *network*.
Direction	A *direction* issued by the *Power System Controller* to any *System Participant* requiring the *System Participant* to do any act or thing

	the *Power System Controller* considers necessary to maintain or re-establish *power system security* or to maintain or re-establish a *power system* in a *reliable operating state* in accordance with this *Code*.
Disconnection, disconnect	In respect of a *connection point*, means to operate switching *equipment* so as to prevent the transfer of electricity through the *connection point*.
Dispatch cost	The cost to the relevant *Generator* associated with fuel, start-up and variable operation, maintenance and other items of the same nature calculated on the basis that the relevant *generating unit* will be dispatched during the *trading day* in accordance with the ~~*Generat'or's*~~*Generator's* expectation.
Dispatch instruction	An instruction given to a *Generator* pursuant to clause 4.7 to *synchronise*, desynchronise, *supply ancillary services* including *spinning reserve* or *supply energy.*
Distribution system	That part or those parts of the electricity *network* used for transporting electricity at nominal *voltage*s of less than 66kV and at a nominal *frequency* of 50Hz.
Economic dispatch	The dispatch of *generating units* that minimises production cost, given *generating unit* and *network constraint*s.
Electricity market	The *electricity market* in its various stages (such as the *I-NTEM*).
Electricity Reform Act	The *Electricity Reform Act 2000* (NT)
Embedded generator	A ~~*Generator*~~ generator which supplies on-site *loads* or distribution *network loads* and is *connected* either indirectly (i.e. via the distribution *network*) or directly to the *transmission network*.
Emergency	Any abnormal system condition which required immediate manual or automatic action to prevent loss of *load*, *equipment* damage, or tripping of system elements which might result in cascading and to restore the system to a *satisfactory operating state*.
Emergency ratings	In respect of a *transmission* line, *transformer* or other element of *equipment* on a *power system*, a rating in excess of the continuous capacity of the *equipment* which may be safely used for limited periods or in specified weather conditions. *Emergency ratings* are advised by the *Network Operator* in accordance with clause 5.6(c).
Energise, energisation	The act of operation of switching *equipment* or the start-up of a *generating unit*, which results in there being a non-zero *voltage* beyond a *connection point* or part of the *network*.
Energy	Active *energy* and/or reactive *energy*.
Energy balancing	In respect of operation in the *Tennant Creek power system* and the *Alice Springs power system*, reconciliation of metered electricity provided to the *power system* by a *Generator* and the metered take of its contracted *customer*s adjusted for *network energy losses*.
Energy loss factor	The amount determined in accordance with clause A6.3.

Energy Loss Factor Code	The most recently published version of the document entitled Northern Territory Energy Loss Factor Code prepared and published by the Utilities Commission.
Energy usage period	A *time* interval defined for reconciliation of *energy* usage, e.g. 15 minutes.
Entry point	A connection point at which electricity is more likely to be transferred to the electricity network than to be transferred from the electricity network.
Exit point	A connection point at which electricity is more likely to be transferred from the electricity network than to be transferred to the electricity network.
Facility	A generic term associated with the apparatus, *equipment*, buildings and necessary associated supporting resources provided at, typically: (a) a *power station* or *generating unit*, including start-up facilities; (b) a *substation* or *power station substation*; or (c) a control centre.
Fast start	*Generating units* for which the *Power System Controller* determines whether to *synchronise* (or de-*synchronise*) the unit to a power system.
Fault level	The current that will flow to a fault on an item of *plant* when maximum system conditions prevail.
Financial year	A period commencing on 1 July in one calendar year and terminating on 30 June in the following calendar year.
Forced outage	System element not in operation due to breakdowns, storms or other unplanned occurrences.
Frequency	For alternating current electricity, the number of cycles occurring in each second. The term Hertz (Hz) corresponds to cycles per second.
Frequency operation standards	The *frequency* standards set out in clause 5.3.1.
Generated	In relation to a *generating unit*, the amount of electrical *energy* produced by the *generating unit* as measured at its terminals.
Generating plant	In relation to a *connection point*, includes all *equipment* involved in generating electrical *energy*.
~~G~~generating system	A system comprising one or more *generating units connected* to a *Network* at a single *connection point*. A system comprising one or more *generating units* and that includes auxiliary or *reactive plant* that is located on the *Generator's* side of the *connection point* and is necessary for the *generating system* to meet its *performance standards.*
g~~G~~enerating unit	~~The actual *Generator* of electricity and all the related *equipment* essential to the *generating un'it's*~~*unit's* ~~operation and functioning as a single entity.~~ The plant used in the production of electricity

	and all related equipment essential to its functioning as a single entity.
Generator	A person who engages in the activity of owning, controlling or operating a *generating system* that is *connected* to a *Network* and, in respect of a *generating system connected* to the *Darwin-Katherine power system*, is either registered by the *Market Operator* as a *Generator* or, intends to register with the *Market Operator* as a *Generator*.
g~~G~~eneration	The production of electrical *energy* by converting another form of *energy* in a *generating unit*.
g~~G~~eneration dispatch	The act of committing to service all or part of the *generation* available from a *scheduled generating unit*.
g~~G~~overnor system	The automatic *control system* which regulates the speed and power output of a *generating unit* through the control of the rate of entry into the *generating unit* of the primary *energy* input (for example, steam, gas or water).
g~~G~~rid	An electric system linking *transmission lines* both *regionally* and locally.
g~~G~~ood electricity industry practice	The exercise of that degree of skill, diligence, prudence and foresight that reasonably would be expected from a significant proportion of operators of facilities forming part of a *power system* for the *generation*, *transmission* distribution and *supply* of electricity comparable to those applicable to the relevant *facility* consistent with applicable laws, the Electricity Reform Act~~Electricity Networks (Third Party Access) Code~~, the *Network Technical Code*, System Control Technical Code, licences, industry codes, *reliability*, safety and environmental protection.
~~I~~interconnected	A *transmission line* or group of *transmission lines* that *connects* the *transmission networks* in adjacent *regions*.
IES	Indigenous Essential Services Pty Ltd
I-NTEM	The Interim Northern Territory Electricity Market, as applied to the *Darwin-Katherine power system*.
Interruptible customer load	A *load* which is able to be *disconnected*, at the discretion of the *Power System Controller*, either manually or automatically initiated, which is provided for the restoration or control of the *power system frequency* to cater for *contingency events* or shortages of *supply*
Load	The amount of electrical *energy* delivered at a defined instant at a *connection point* or aggregated over a group of *connection points*.
Load following services	Where a *Generator* follows the *load* of its *customers* plus *network losses*, plus whatever transfer commitments to another *Generator*.
Load shedding	Reducing or *disconnecting load* from a *power system*.
Major reportable incident	Refer to clause 7.3.2.

Market Customer	*Customers* who make payments or virtual payments (as the case may be) for purchase of electricity direct to one or more *Generator* or the *Market Operator*.
Market Information	The *Market Information* specified in Attachment 6.12
Market Operator	A role fulfilled by the *Power System Controller* in accordance with clause 1.7.5.
Market Participant	A *Generator* or *Market Customer* who registers for participation in the *electricity market*.
Market Price	The price determined for each *trading interval* in accordance with clause 4.8 and the methodology provided in Attachment 5.
Market Price Principle	The principle set out in clause 4.8(b).
Minor reportable incident	Refer to clause 7.3.3.
Month	Unless otherwise specified, the period beginning at 12.00 am on ~~th“e~~the "relevant commencement ~~da”te~~date" and ending at 12.00 am on the date in ~~th“e~~the "next calendar ~~*mon”th”*~~*month* corresponding to the commencement date of the period. If ~~th“e~~the "relevant commencement ~~da”te~~date" is the 29th, 30th or 31st and this date does not exist in ~~th“e~~the "next calendar ~~*mon”th*~~*month*", then the end date in ~~th“e~~the "next calendar ~~*mon”th*~~*month*" shall be taken as the last *day* of that month.
Network	The *connection* assets and *network* system assets which together are operated by the *network* provider for the purposes of transporting electricity from *Generators* of electricity to a transfer point or to consumers of electricity.
Network energy losses	The *energy* loss incurred in the transportation of electricity from an *entry point* or transfer point to an *exit point* or another transfer point on a *network*.
Network Operator	~~A body defined as a “*network* provider” in the Electricity Networks (Third Party Access) Act.~~ person defined as a ‘network provider’ under section 4(1) of the *Electricity Reform Act* as in force at 1 June 2019.
Network Technical Code	The Code specified in the Electricity Reform Act and prepared by Power and Water ~~under its Network Licence~~in accordance with the Electricity Reform (Administration) Regulations.
Network User	Any person or body that has entered into a~~n~~ ~~*access*~~ *connection agreement* with the *Network Operator* to convey electricity from an *entry point* to an *exit* ~~*supply*~~ *point*.
Nomenclature , nomenclature standards	The ~~standards approved by the *Network Operator* and endorsed by the *Power System Controller*~~ principles relating to numbering, terminology and abbreviations used for information transfer by *System Participants* and *Network Users* ~~as provided for in~~ in accordance with clause 6.14.
Non-scheduled generating unit	A *generating unit* which is classified by the *Power System Controller* as non-scheduled in accordance with 3.2.3(b) or as defined in clause 3.2.3(~~c~~d).

Non-credible contingency event	A *contingency event* other than a *credible contingency event* as defined in clause 3.2.7.
Normal operating frequency band	In relation to the *frequency* of the *power system*, means the range specified in clause 5.3.1(a).
NT NER	The National Electricity Rules as applicable in the Northern Territory.
Off-peak period	The 12 hour period ending at 0600 hours over adjacent weekdays as well as the 60 hour period ending 0600 hours on the first *day* after a weekend (note that a public holiday is classified as a weekday for this definition).
Operating protocol	A document prepared and published by the Power System Controller that details the communications and control systems required to be in place to enable and support the dispatch process and to monitor performance.
Operational communication	A communication concerning the arrangements for or actual operation of a *power system* in accordance with the *Code*.
Out of balance energy	The difference between the metered electricity provided by a *Generator* and the metered consumption of electricity by its contracted *customer*s adjusted for *network energy losses*. *Out of balance energy* can be in surplus or deficit.
Outage	Any planned or unplanned full or partial unavailability of *plant* or *equipment*, inclusive of *performance issue outages*.
Over supplied market	A market situation when the *Generators* are producing more *energy* than the market requires, and the *frequency* control service provider has to pull back in production.
Peak period	The 12 hour period ending at 1800 hours on a weekday (note that a public holiday is classified as a weekday for this definition).
Performance issue outages	*Power System Controller* or *System Participant* required outages to address performance issues such as forecasting errors, insufficient ancillary service contributions, auxiliary equipment performance, and any other performance issues that might impact on the secure operation of the *power system*.
Planned outage	System elements not in operation due to planned maintenance or other planned occurrences
Plant, equipment	Includes all *equipment* involved in generating, utilising or transmitting electrical *energy*.
Post-trip management	The maintenance of system security in the aftermath of trips.
Power and Water Corporation	The body corporate established under the *Government Owned Corporations Act*.
Power factor	The ratio of the active power to the apparent power at a point.
Power flow	A generic term used to describe the type, *direction*, and magnitude of actual or simulated electrical *power flows* on electrical systems.

Power station	In relation to a *Generator*, a *facility* in which any of that *Generator*'s *generating units* are located.
Power system	The *generation* facilities and electricity *network* facilities which together are integral to the *supply* of electricity, operated as an integrated arrangement.
Power System Controller	The entity licenced by the Utilities Commission pursuant to section 30 of the Electricity Reform Act.
Power System Operating Procedures	The procedures to be followed by *Network Users* in carrying out operations and /or maintenance activities on or in relation to primary and secondary *equipment connected* to or forming part of a *power system* or *connection points*, as described in clause 6.1.
Power system security	The safe scheduling, operation and control of a *power system* on a continuous basis in accordance with the principles set out in clause 3.3
Power system stabiliser	An auxiliary control device *connected* to an excitation *control system* to provide additional feedback signals to reduce *power system* oscillations.
Power transfer	The instantaneous rate at which active *energy* is transferred between *connection points*.
Pre-dispatch schedule	A schedule for each *trading interval* determined on the basis of information including *commitment and dispatch submissions* and setting out forecasts of the *Market Price*, system demand and dispatch levels for each *generating unit* that was offered by a *Generator*.
Protection system	A system which includes all the protection schemes applied to the system.
Publish, publishing, publication	The provision of a document in the public domain that can be readily accessed by the general public.
Quality of supply	Refers to, with respect to electricity, technical attributes to a standard referred to in the *Network Technical Code*, or as agreed in a ~~n access~~*connection* *agreement* with the *Network User*.
Reactive plant	*Plant* which is normally specifically provided to be capable of providing and/or absorbing *reactive power*
Reactive power	The rate at which reactive *energy* is transferred. *Reactive power* is a necessary component of alternating current electrical power which is separate from active power and is predominantly consumed in the creation of magnetic fields in motors and *transformer*s and produced by *plant* such as: (a) alternating current *Generators*; (b) capacitors, including the capacitive effect of power lines; or (c) *synchronous condensers*.
Reactive power capability	The maximum rate at which reactive *energy* may be transferred from a *generating unit* to a *connection point* as specified in an *access agreement*.

Reactive power reserve	Un-utilised sources of *reactive power* arranged to be available to cater for the possibility of the unavailability of another source of *reactive power* or increased requirements for *reactive power*.
Reactor	A device, similar to a *transformer*, specifically arranged to be *connected* into the *network* during periods of low *load* demand or low *reactive power* demand to counteract the natural capacitive effects of long *transmission lines* in generating excess *reactive power* and so correct any *voltage* effects during these periods.
Recall time	The lead-*time* specified on an *outage* request that the *plant* can be restored to service.
Region	An area determined by the *Network Operator*, being an area served by a particular part of the *transmission network* containing one or more major *load* centres or *generation* centres or both.
Registered operator	A person approved by the *Power System Controller* to *operate power system equipment*.
Regulating reserve	The capability of a *Generator* or *Generators* to provide the marginal increase or decrease of *power system* demand.
Regulating unit	*Generating plant* arranged by the *Power System Controller* and specifically allocated to *frequency* regulating duty. Such *plant* can be automatically controlled or directed by the *Power System Controller* to ensure that all normal *load* variations do not result in *frequency* deviations outside designated limits as specified in the System Control Technical Code.
Reliability	The probability of a system, device, *plant* or *equipment* performing its function adequately for the period of *time* intended, under the operating conditions encountered.
Reliable	The expression of a recognised degree of confidence in the certainty of an event or action occurring when expected.
Reliable operating state	In relation to a *power system*, has the meaning given in clause 3.2.11.
Remote monitoring facilities	*Equipment* installed to enable monitoring of a *facility* from a control centre, including a remote terminal unit (RTU).
Reportable incident	A *power system* event that had, or could have had, a significant effect on the security or *reliability* of *supply*, as defined in clause 7.3.1.
Reserve, reserves	The active power and *reactive power* available to a *power system* at a nominated *time* but not currently utilised.
Revenue energy meter	A device complying with Australian Standards which measures and records the production or consumption of electrical *energy* that is used for obtaining the primary source of revenue metering data.
Ring Fencing Code	The Northern Territory Electricity Ring-Fencing Code made by the *Utilities Commission* pursuant to section 24 of the *Utilities Commission Act.*

Satisfactory operating state	In relation to a *power system*, has the meaning given in clause 3.2.6.
SCADA system	Supervisory control and data acquisition *equipment* which enables the *Power System Controller* to continuously and remotely monitor, and to a limited extent control, the import or export of electricity from or to a *power system*.
Scheduled generating unit	A *generating unit* which is classified ~~dispatched~~ by the *Power System Controller* as scheduled in accordance with clause 3.2.3(b).
Secure system, secure operating state	In relation to a *power system* has the meaning given in clause 3.2.9.
Secure System Guidelines	The guidelines prepared by the *Power System Controller* which contains the principles specified in clause 3.5.1.
Security Constrained Economic Dispatch	*Economic Dispatch* which achieves a *secure operating state*.
Self-commitment, Self-committed	*Generating units* for which the *Generator* makes the (primary) decision to *synchronise* (or de-*synchronise*) the unit to a power system (subject to permission to proceed from the *Power System Controller*).
Semi-scheduled generating unit	A *generating unit* which is classified by the *Power System Controller* as semi-scheduled in accordance with 3.2.3(b).
Settlements	The activity of producing virtual invoices and virtual credit notes for *Market Participants*.
Settlements period	For the *I-NTEM*, a period of one calendar *month*.
Single credible fault	A *single credible fault* considered by the *Power System Controller*, in particular circumstances, to have the potential for the most significant impact on a *power system* at that *time*. This would generally be the instantaneous loss of the largest *generating unit* or a fault on a major *network* element on a *power system*. Under normal conditions, the design or operation of the relevant part of a *power system* would adequately cater for a *single credible fault*, so as to avoid significant disruption to *power system security*.
Spinning reserve	The ability to immediately and automatically increase *generation* or reduce demand in response to a fall in *frequency*.
SPRINT	SPRay INTercooling, a technique used in turbine engines to enhance the efficiency and output of the engine.
Stand-by power, generation	The amount of electrical *energy* which could be supplied to a *load* user in accordance with the terms of a stand-by *generation* agreement.
Statement of Calculation	A document of 1 page or more that carries the information specified in clauses A6.10 and A6.11 applicable to the relevant *Market Participant*.

Static VAR compensator	A device specifically provided on a *network* to provide the ability to generate and absorb *reactive power* and to respond automatically and rapidly to *voltage* fluctuations or *voltage* instability arising from a disturbance or disruption on the *network*.
Substation	A *facility* at which lines are switched for operational purposes. May include one or more *transformer*s so that some *connected* lines operate at different nominal *voltage*s to others.
Supply	The delivery of electricity.
Synchronise	The act of *synchronising* a *generating unit* to a *power system*.
Synchronising, synchronisation	To electrically *connect* a *generating unit* to a *power system*.
Synchronous condensers	*Plant*, similar in construction to a *generating unit* of the *synchronous Generator* category, which operates at the equivalent speed of the *frequency* of a *power system*, specifically provided to generate or absorb *reactive power* through the adjustment of excitation current.
Synchronous Generator voltage control	The automatic *voltage control system* of a *generating unit* of the *synchronous Generator* category which *changes* the output *voltage* of the *generating unit* through the adjustment of the *Generator* excitation current and effectively *changes* the *reactive power* output from that *generating unit*.
Synchronous Generator	The alternating current *Generators* which operate at the equivalent of the *frequency* of a *power system* in its *satisfactory operating state*
System Participant	A person or body, licensed by the Utilities Commission, who inputs, transports, controls, operates or takes electricity from any part of a *power system*.
Tap-changing transformer	A *transformer* with the capability to allow internal adjustment of output *voltage*s which can be automatically or manually initiated and which is used as a major component in the control of the *voltage* of the *network*s in conjunction with the operation of *reactive plant*.
Tennant Creek Power System	The *power system* located in the *region* of Tennant Creek operated pursuant to licences issued by the Utilities Commission pursuant to Part 3 of the Electricity Reform Act.
Time	Central Australian Standard Time, as defined by the *National Measurement Act*.
Transformer	A *plant* or device that reduces or increases the *voltage* of alternating current.
Trading interval	A 30 minute period ending on the hour (Australian Central Standard Time) or on the half hour and, where identified by a *time*, means the 30 minute period ending at that *time*.
Trading day	The 24 hour period ending at 0400 hours on a calendar *day*.

Transaction Reference Point	The *connection point* on the *Power and Water Corporation*'s *electricity network* that relates to a *Market Customer*'s *supply* of electricity.
Transmission, transmission system	Activities pertaining to a *transmission network* including the conveyance of electrical *energy*.
Transmission capacity	The capacity of the *transmission network* to transmit power between two or more points under the full range of operating conditions likely to be experienced in service.
Transmission line	A power line that is part of a *transmission network*.
Transmission network	That part or those parts of the electricity *network* used for transmitting electricity at nominal *voltage*s of 66kV or higher and at a nominal *frequency* of 50Hz.
Under supplied market	A market situation when the *Generators* are producing less *energy* than the market requires, and the *frequency* control service provider has to increase in production.
Unit commitment	Contained in the definition of Dispatch Instruction, as part of the synchronisation process.
Unit de-commitment	Contained in the definition of Dispatch Instruction, as part of the de-synchronisation process.
Unit protection	Generally, a protection scheme that compares the conditions at defined primary *plant* boundaries and can positively identify whether a fault is internal or external to the protected *plant*. *Unit protection* schemes can provide high speed (less than 150 milliseconds) protection for the protected primary *plant*. Generally, *unit protection* schemes will not be capable of providing back up protection.
Unplanned outage	*Outage*s of system element not notified in advance to the *Power System Controller*.
Virtual Settlements Statement	A document of 1 page or more that carries the information as specified in clause A6.7(d), as applicable to the relevant *Market Participant*.
Voltage	The electronic force or electric potential between two points that gives rise to the flow of electrical *energy*.
Voltage control	Keeping *network voltage*s within operational limits in normal operation and in the aftermath of trips by automatic regulation of *generation* MVAr output or by *voltage control equipment* such as *capacitor banks* and automatic tap-changers.
Wet Mode	That range of capacity of a gas turbine unit where water injection is applied. One technique used to provide water injection is known as *SPRINT*. This term is used in the *Generator* standing data.

ATTACHMENT 2 RULES OF INTERPRETATION

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

(a) a reference in this *Code* to a contract or another instrument includes a reference to any amendment, variation or replacement of it;

(b) a reference to a person includes a reference to the person's executors, administrators, successors, substitutes (including, without limitation, persons taking by novation) and assigns;

(c) if an event shall occur on a *day* which is not a *business day* then the event shall occur on the next *business day*;

(d) any calculation shall be performed to the accuracy, in terms of a number of decimal places, determined by the *Network Operator* in respect of all *Network 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 *Network User*'s *connection* or a *connection* of a *User* if it is the subject of an *access agreement* between the *Network User* and the *Network Operator*;

(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*; and

(h) the italicised expressions in this *Code* are recorded in Attachment 1.

ATTACHMENT 3 DOCUMENT REVISION HISTORY

Version 1 Published July 2002

Version 2 Published June 2008

- Amended and clarified references to *Secure System Guidelines*.
- Established asset owner responsibilities to maintain a register of those who can operate on their High Voltage *network*.
- Removed Attachment 3, direct contact details for individuals within System Control, as this is inappropriate information for the System Control Technical Code.
- Removed Attachment 4, standard phonetic alphabet, as this is inappropriate information for the System Control Technical Code.

Version 3 Published May 2010

- Introduced requirement for *Generator* Performance Capability Reporting and Compliance.
- Amended reporting requirements in regards to *Generator* AVR reporting.
- Included references to and confirmed hierarchy of interpretation of Ring Fencing Guidelines.
- Simplified management of Low *Stand-by Generation* Conditions.
- Simplified management of *Time* Correction obligations.
- Rationalised System Control reporting obligations.

Version 4 Published June 2012

- Section 3 augmented – greater detail on responsibilities of *Power System Controller* and *System Participants*, System Control responsibility in defining and re-defining *credible contingency events*.
- Provisions of clause 3.2.11 aligned with proposed *Network Planning Criteria.*
- *Black system* procedures in clause 5.7.2 clarified, clause 5.7.3 added.
- Clause 6.14(c) removed to accommodate audit finding.
- Clause 6.18(f) *changed* to clarify *participant* obligations on failure of *remote monitoring* or alarms.
- Clause 6.22 added – auditing of *equipment* technical standards.
- New Section 7 on *power system* reporting procedures. Existing Section 7 on Other Matters renumbered as Section 8.
- Alterations to glossary to accommodate these *changes*.

Version 5 Published May 2015

- This version provides for the operation of an interim competitive *electricity market* (*I-NTEM*) in the *Darwin-Katherine power system*. The provisions are the first step towards more sophisticated and complete market arrangements and further *change* is anticipated as experience and facilities allow. The initial market provisions are by design extensions of previous processes.

- *Changes* to the role of the *Power System Controller* include:
    - o Removal of the references to an *energy balancing* market in the *Darwin-Katherine power system*;
    - o Arrangements to permit *Generators* to *self-commit* or to *fast start*;
    - o *Changes* to the dispatch process in that a *pre-dispatch schedule* will be produced in addition to real *time* dispatch;
    - o Calculation of a *Market Price* for each half hour (*trading interval*).
- The role of a *Market Operator* has been enhanced in this version to support the commencement of the *I-NTEM*.

Version 6 ~~Consultation Draft December 2018~~[To be completed when changes approved]
Amended to accommodate changes to the NTC to remove duplication, provided consistency between the two documents, correct minor typos, and make minor editorial changes to improve readability.

Substantive changes have been made to the following provisions:

- Clause 3.3.3 Responsibilities of the Network Operator.
- Clause 6.7.4 Protocols for protection or control system abnormality.
- Clause 6.14 Plant numbering, Nomenclature and Drawings.

Minor changes have been made to the following provisions:

- Clause 1.1 opening paragraph. Delete 'Technical' and in all other instances throughout the Code.
- Clause 1.2(e) apply italics to Network Technical Code. Define in Glossary.
- Clause 1.3 Application. Change to paragraph (f).
- Clause 1.4 Interpretation. Change paragraph (d).
- Clause 1.7.4 Obligations of the Power System Controller. Change paragraph (a).
- Clauses ~~3.1(c)(4), ~~3.2.3(b)~~(2), 3.3.1(h)~~: Restructuring for clarity~~delete reference to semi-scheduled generating unit.~~
- Clause 3.3.1 Responsibility of System Controller. Change to paragraph (d).
- Clause 3.3.1 Responsibility of System Controller. Change to paragraph (s).
- Clause 7.3.4 Incident reporting guideline. Change may to shall and define term Incident Reporting Guideline.
- Clause 7.4.1 Notification of a reportable incident.
- Clause 7.5 Public reporting. New paragraph (b).
- Glossary definitions. Various changes to better align with NTC and NT NER definitions.
    - ~~New definitions: Network Technical Code, Ring Fencing Code, Secure System Guidelines, unit commitment, unit de-commitment.~~
    - ~~Changes to: Code, dispatch instruction, embedded generator, nomenclature, network energy losses, Network User.~~
    - ~~Deletion: Semi-scheduled generating unit, Technical Code.~~

ATTACHMENT 4 *GENERATOR* COMMITMENT AND DISPATCH TEMPLATE

The Commitment and Dispatch Template is shown below. The instructions for filling out the template are contained within the template. Generating unit standing data is to be provided elsewhere (within the Market Participant Registration process).

For trading day commencing <<dd/mm/yyyy>>	**Issuer**	**<<name of person sending Offer>>**
		<<title of person sending Offer>>
	Date of issue	**<<dd/mm/yyyy>>**
	Issues version	**<<v1>>**
	Company	**<<company name>>**

			Self-commitment units										Fast start units										
Primary order index		**Standard Unit ID**	**off-load order**	**Time of sync (on-line)**	**Time of de-sync (off-line)**	**B1: minimum stable load**	**B1 OFFER**	**B2: incremental capacity**	**B2 OFFER**	**B3: incremental capacity**	**B3 OFFER**	**total offered capacity (check)**	**T1: Time to start**	**T2: Time to reach min load**	**T3: Minimum run time**	**T4: Time to reduce to zero**	**B1 minimum stable load**	**B2: incremental capacity**	**B2 OFFER - LONG RUN (Set 1)**	**B2 OFFER - SHORT RUN (Set 2)**	**B3: incremental capacity**	**B3 OFFER**	**total offered capacity (check)**
			Number	hhmm	hhmm	MW	$/MWh	MW	$/MWh	MW	$/MWh	MW	mm	mm	mm	mm	MW	MW	$/MWh	$/MWh	MW	$/MWh	MW
1												0											0
2												0											0
3												0											0
4												0											0
5												0											0
6												0											0
7												0											0
8												0											0
9												0											0
10												0											0
11												0											0
12												0											0
13												0											0
14												0											0
15												0											0
16												0											0
17												0											0
18												0											0
19												0											0
20												0											0
21												0											0
22												0											0
23												0											0
24												0											0
		Band totals				0		0		0							0	0			0		

ATTACHMENT 5 INITIAL MARKET PRICE METHODOLOGY

The following methodology is to be applied to the determination of the *Market Price* for each half hour period in accordance with clause 4.8.

The *Market Price* for each *trading interval* is the price of the highest priced band of flexible (or unconstrained) *generation* which is dispatched in that *trading interval.* The calculation of the *Market Price* must, to the extent it is consistent with the above statement, be undertaken by the following steps:

Input data:

A 30 minute *energy* produced by each *scheduled generating unit*

B Price-volume data in final *commitment and dispatch submissions*

C Information and data relating to *energy* that has been *constrained* on as a result of system or *network constraints* by the *Power System Controller* or by a *Generator* in accordance with a minimum loading of a *generating unit* classified as a *self-committed generating unit* for each *scheduled generating unit*.

Calculation steps

1. Allocate Input data A to price bands described by Input data B
2. Allocate Input data C to price bands described by Input data B
3. For each half hour and each scheduled *Generator* subtract the result of Calculation step 2 from Calculation step 1.
4. Set *Market Price* in each half hour to the highest priced MW in Calculation step 3.

ATTACHMENT 6 *MARKET OPERATOR*

The duties of the *Market Operator* for the *I-NTEM* are set out in this Attachment 6.

A6.1 RESPONSIBILITIES OF THE *MARKET OPERATOR*:

The *Market Operator* responsibilities include:

(a) Administering *Market Participant* registration process.

(b) Managing the *electricity market settlements* arrangements. This includes:

(1) Calculation of the virtual charges for *Market Customers* and the virtual payments to *Generators* for the *supply* of *energy* to *Market Customers*;

(2) The provision of virtual invoices and credit notes for the *supply* of *energy* to *Market Customers*, as appropriate, to *market participants* whilst the *I-NTEM* is operating on a virtual basis;

(3) The calculation of *ancillary services* financial transactions and the issue of *Statements of Calculation* for those transactions to the relevant parties;

(4) The calculation of financial transactions for *out of balance energy* and the issue of *Statements of Calculation* for those transactions to the relevant parties.

For the removal of doubt:

(i) The *Market Operator* is responsible for the calculation of *Statements of Calculation* in respect to *ancillary services* and *out of balance energy* financial transactions.

(ii) It is for the Generators to invoice each other directly for *ancillary services* and *out of balance energy* financial transactions based on the *Statements of Calculation* issued by the *Market Operator*.

(c) Daily *publication* of the *Market Price*, *pre-dispatch schedule*, actual dispatch targets, actual *constraints*, and total system demand, or as otherwise established in accordance with clause 4.8(f);

(d) Prepare and *publish* plans, specifications and designs (or similar) for market operation processes and systems necessary for the efficient operation of the *I-NTEM*;

(e) Prepare and *publish* procedures and guidelines (or similar) where appropriate for deployment by *Market Participants* and / or the *Market Operator* necessary for the efficient operation of the *I-NTEM*.

(f) Conduct reasonable consultation with *electricity market* stakeholders prior to the *publication* of the documents specified in A6.1 (d) and (e).

A6.2 *MARKET PARTICIPANT* REGISTER

The *Market Operator* must develop (in consultation with *electricity market* stakeholders) and administer a register of *Market Participants* who elect to participate in the *electricity market*, including the relevant attributes specified by the *Market Operator* that the *Market Operator* reasonably believes are required for the *Power System Controller* and the *Market Operator* to perform their duties.

A6.3 *NETWORK ENERGY LOSS FACTOR*

(a) The *Network Operator* must provide the following information to the *Market Operator* in accordance with the timeframe agreed between those parties:

(1) The *energy loss factor* for all *connection points* other than *Generator connection points*, as determined by the *Network Operator* pursuant to the *Energy Loss Factor Code*; and

(2) The *energy loss factor* for a *Generator's connection point*, which shall be 1.0 per unit unless otherwise advised by the *Network Operator*.

(b) The *Network Operator* shall review and update the *energy loss factors* annually.

A6.4 REVENUE METERING DATA

(a) The *Network Operator* is responsible for forwarding interval or consumption data from suitable meters to the *Market Operator* for use in *settlements* for the *I-NTEM*.

(b) Wherever practicable data for *settlements* of the *electricity market* is to be based on:

(1) Revenue class meters used for *customer* billing where that data records *energy* consumed over *trading intervals* and is reliably available no later than four *business days* after the end of each *settlements period.*

(2) Revenue class meters used for determining *Generator* sent out *energy* where that data records *energy generated* over *trading intervals* and is reliably available no later than four *business days* after the end of each *settlements period*.

(3) Meters that are not revenue class and can be used on a temporary basis until revenue class meters become available.

(c) If interval meter data is not available for some *customers*, *settlements* is to be based on:

(1) *Peak period* meter data and *off-peak period* meter data; or

(2) Calculated data that represents a reasonable estimate of the missing meter data and may include use of calculation by difference between data based on available meter data and deemed load profile procedures.

(d) Consumption meter data for *IES customers* is to be profiled in *trading intervals* (or otherwise in *peak period* and *off-peak period* until a suitable *trading interval* algorithm is determined by the *Market Operator*) according to an algorithm developed, consulted with *electricity market* stakeholders and *published* by the *Market Operator*.

(e) Interval meter data is to be used where it is readily available or at a minimum for those *connection points* where the *customer* consumes over 750 MWh per annum.

(f) Interval meter data is to be used from *Generators* on a *generating unit* sent-out basis as soon as reasonably possible or, until suitable *generating unit* metering is available, as agreed between the *Network Operator* and the *Market Operator*.

A6.5 *SETTLEMENTS* CYCLE

(a) The *settlements* cycle is to be based on the *settlements period*.

(b) The timing of preliminary, final and revision *settlements* statements is to be as specified in the *settlements* timetable in accordance with sub-section A6.6. The *Market Operator* may perform adhoc revisions from time to time in accordance with requirements specified in a procedure.

(c) For the purposes of assessing the veracity of the calculation of quantities for *settlements*, a comparison between quantities determined according to clause A6.4 and quantities available from the sum of all forms of physical metering is to be undertaken every three *months*. This clause will not apply if the metering for the quantities being compared use the same source;

(d) The comparison under A6.5(c) may be in the form of commentary or other form at the discretion of the *Market Operator*.

A6.6 *SETTLEMENTS* TIMETABLE

(a) The *Market Operator* must *publish* a *settlements* timetable for the *I-NTEM*.

(b) The *settlements* timetable is to be *published* within one *month* of *I-NTEM* commencement.

(c) The *settlements* timetable is to be revised as and when required by the *Market Operator*.

(d) The *settlements* timetable is to apply to the *virtual settlements statements* only.

A6.7 *SETTLEMENTS* STATEMENTS AND *STATEMENTS OF CALCULATION*

(a) Statements are to carry the description of *virtual settlements statement* or *Statements of Calculation* as the case may be for the *I-NTEM*.

(1) A *virtual settlements statement* does not require a *Market Participant* to pay or entitle a *Market Participant* to receive any amounts specified on the statement.

(2) A *Statement of Calculation* triggers a right for a *Market Participant* to issue an invoice to another *Market Participant* for the amounts specified on the statement. A *Market Participant* who receives an invoice based on a *Statement of Calculation* must pay the invoice.

(b) *Trading interval* meter data is to be used where relevant in preparing *settlements* statements (or otherwise *peak period* and *off-peak period* meter data is to be used until *trading interval* meter data becomes readily available to the *Market Operator*).

(c) *Virtual settlements statements* and *Statements of Calculation*, as the case may be, are to contain information that has been determined in accordance with clauses A6.8, A6.9. A6.10. A6.11.

(d) The *virtual settlements* statements produced by the *Market Operator* must include at least the following information:

(1) For *Generators*:

(i) Total daily sent out *energy* for each *Generator*.

(ii) Total *monthly* sent out *energy* for each *Generator*, including *peak period* and *off-peak period* components.

(iii) Total daily revenue for each *Generator*.

(iv) Total *monthly* revenue for each *Generator*, including *peak period* and *off-peak period* components.

(v) Average daily price for each *Generator*.

(vi) Average *monthly* price for each *Generator*.

(2) For *Market Customers*:

(i) The total daily *energy* by each *Market Customer*.

(ii) The total *monthly energy* by each *Market Customer,* including *peak period* and *off-peak period* components.

(iii) The total daily amount (that would otherwise be payable) by each *Market Customer*.

(iv) The total *monthly* amount (that would otherwise be payable) by each *Market Customer*, including *peak period* and *off-peak period* components.

(v) Average daily price for each *Market Customer*.

(vi) Average *monthly* price for each *Market Customer*.

(vii) *Monthly* market volume weighted *peak period* and *off-peak period* prices for each *Market Customer*.

A6.8 *SETTLEMENTS* CALCULATIONS

(a) The arrangements in clause A6.8 are to apply for *virtual settlements statements*.

(b) The *Market Operator* must calculate virtual amounts payable to *Generators* and virtual amounts receivable from *Market Customers* in respect of each *trading interval* (or otherwise in *peak periods* and *off-peak periods* until *trading interval* data becomes readily available to the *Market Operator*) within each *settlements period*.

(c) Amounts payable to *Generators* shall be calculated according to the following formula:

GP = MP X MSO X LF(G)

Where:

GP is amount payable to a *Generator* in respect of the *trading interval*

MP is the *Market Price* determined in accordance with clause 4.8

MSO is the *Metered Sent Out energy* determined in accordance with clause A6.4

LF(G) is the *loss factor* applicable to the *Generator's connection point* as specified in clause A6.3(a)(2).

(d) Amounts payable by *Market Customers* shall be calculated according to the following formula:

MCP = MP X MCM X LF(C)

MCP is amount payable by a *Market Customer* for the *trading interval,* unless otherwise determined by the *Market Operator* in consultation with the relevant *Market Customer*.

MP is the *Market Price* determined in accordance with clause 4.8.

MCM is the *Market Customer's* metered consumption determined in accordance with clause A6.4

LF(C) is the *loss factor* applicable to the *customer* determined in accordance with A6.3(a)(1).

(e) The *Market Operator* shall aggregate the amounts payable to each *Generator* and payable by each *Market Customer* in each *trading interval* over a *settlements period* (in accordance with the *settlements* statement requirements in clause A6.7(d)) and advise each *Generator* and *Market Customer* of the amounts payable to or payable by each individual entity, as appropriate.

A6.9 CALCULATED DATA FOR JACANA ENERGY

(a) The arrangements in clause A6.9 are to apply for *virtual settlements statements*.

(b) The following figure specifies the first part of the calculation to be performed for determining Jacana Energy's consumption data:

Generator revenue	=	Pool price * Generator sent out volume
	=	Pool price * customer meter vol / (1-Loss factor)

AND
Referring meter volumes to the Transaction reference point

Total generators sent out volume	=	J+IES meter vol/(1-Loss(Jav))
	+	JACint(D-HV) meter vol)/(1-Loss(D-HV))
	+	JACint(D-LV) meter vol)/(1-Loss(D-LV))
	+	JACint(K-HV) meter vol)/(1-Loss(K-HV))
	+	JACint(K-LV) meter vol)/(1-Loss(K-LV))
	+	R(D-HV) meter vol)/(1-Loss(D-HV))
	+	R(D-LV) meter vol)/(1-Loss(D-LV))
	+	R(K-HV) meter vol)/(1-Loss(K-HV))
	+	R(K-LV) meter vol)/(1-Loss(K-LV))

JACint = Jacana customers supplied under contestable contracts ie excluding
excluding Jacana customers with interval meters remaining on franchise tariff (x200)
JACint meter vol = sum of ~200 interval meters (split into (the four) loss factor regions)
The only unknown volume is J+IES and it must be calculated by difference

Figure A6.1 – first part of the calculations for *Jacana Energy's consumption data*

(c) The following figure specifies the second part of the calculation to be performed for determining Jacana Energy's consumption data:

J+IES meter vol at Transaction ref pt

	=	[Total generators sent out (SCADA data) vol
	-	JACint (D-HV) meter vol / (1-Loss(D-HV)
	-	JACint (D-LV) meter vol / (1-Loss(D-LV)
	-	JACint (K-HV) meter vol / (1-Loss(K-HV)
	-	JACint (K-LV) meter vol / (1-Loss(K-LV)
	-	R(D-HV) meter vol) / (1-Loss(D-HV))
	-	R(D-LV) meter vol) / (1-Loss(D-LV))
	-	R(K-HV) meter vol) / (1-Loss(K-HV))
	-	R(K-LV) meter vol) / (1-Loss(K-LV))]
	*	1 - Loss(Jav)

THEREFORE

Total Jacana payments	=	Sum		[J+IES meter vol * Pool price/(1-Loss(Jav)
			-	IES deemed vol * Pool price/(1-Loss(Jav)
			+	JACint (D-HV) meter vol * Pool price/(1-Loss(D-HV)
			+	JACint (D-LV) meter vol * Pool price/(1-Loss(D-LV)
			+	JACint (K-HV) meter vol * Pool price/(1-Loss(K-HV)
			+	JACint (K-LV) meter vol * Pool price/(1-Loss(K-LV)]

Where Jav is the average weighted loss factor of the non-accumulation meters (assumed at LV only) for Darwin and Katherine systems

Retailer payments	=	Sum		[R (D-HV) meter vol * Pool price/(1-Loss(D-HV)
			+	R (D-LV) meter vol * Pool price/(1-Loss(D-LV)
			+	R (K-HV) meter vol * Pool price/(1-Loss(K-HV)
			+	R (K-LV) meter vol * Pool price/(1-Loss(K-LV)]

Figure A6.2 – second part of the calculations for Jacana Energy consumption data

A6.10 *OUT OF BALANCE ENERGY CALCULATIONS*

(a) The calculations in clause A6.10 are to be prepared as *Statements of Calculation*.

(b) A *Generator* will be out of balance by a quantity Q in the event it generates more (surplus) or less (deficit) than the sum of its *Market Customer*(s)' contracted load (meter data and/or aggregated data), where:

(1) Quantity (Q) = An amount to be determined by the *Market Operator* based on the contracts entered between *Generators* and *Market Customers* and the principle that it represents the difference between the loss adjusted quantity of *energy* produced by or on behalf of a *Generator* (which may be under a stand-by contract with another *Generator*) and the aggregate quantity of *energy* consumed pursuant to contracts between that *Generator* and *Market Customers*.

(2) Q is to be determined for each *trading interval* over the *settlements* period.

(3) The detailed workings in producing Q are to be made available to the affected *Generators*.

(c) The *Market Operator* is to determine Q as specified in subclause A6.10(b) in accordance with a method contained in a document prepared and duly approved by the relevant *Generators*.

(1) The method specified in this subclause is to be acceptable to the *Market Operator*, whose acceptance cannot be unreasonably withheld.

(2) The document specified in this subclause may be amended from time to time by the *Generators* in accordance with a process agreed by the relevant *Generators*.

(3) The detailed workings in determining Q for each *settlements period* are to be made available to the affected *Generators*.

For the removal of doubt:

(i) the *Market Operator* is not required to determine Q if the method specified in this subclause has not been presented or is not reasonably acceptable to the *Market Operator*;

(ii) the *Market Operator* must prepare retrospective calculations of Q if the document specified in this subclause is not available to the *Market Operator* until some time after the commencement of the I-*NTEM*.

(d) The out of balance energy price ('OOBPrice') is $65/MWh.

(e) In accordance with subclauses A6.10(b) and A6.10(c), the *Market Operator* is to determine a payment for *out of balance energy* in accordance with the following formula:

Payment = Q x OOBPrice

Where:

A *Generator* in surplus will be entitled to receive a payment and the *Generator* in deficit must pay that amount to the other *Generator*.

(f) The affected *Generators* are to provide within two *business days* after the end of the *settlements period* the *Market Operator* with sufficient information per *trading interval* in order to determine the *out of balance energy*.

(1) The *Market Operator* must provide the *Statements of Calculation* to the affected *Generators* within five *business days* after the receipt of the information provided in subclause A6.10(f).

(g) The information determined in accordance with subclauses A6.10(b) and (e) is to be provided to the *Generators* in the form of a *Statement of Calculation*.

(h) After receipt of a *Statement of Calculation* for a *settlements period*, a *Generator* in surplus must issue an invoice to the *Generator* in deficit for the amount stated in the *Statement of Calculation*.

(i) The *Generator* in deficit must pay the invoice within thirty calendar days of the date of the invoice.

(j) A *Generator's* right to be paid or credited an amount in an invoice issued in accordance with this subclause A6.10 is enforceable between the relevant parties as a contract.

A6.11 *ANCILLARY SERVICES CALCULATIONS*

(a) The calculations in clause A6.11 are to be prepared as *Statements of Calculation*.

(b) In respect of every *trading interval* a *Generator* must make a payment to Territory Generation in respect of *ancillary services*. The amount of the payment is to be calculated in accordance with the following formula:

Payment = ASQuantity x ASPrice

Where:

ASQuantity = The *energy* produced (by one or more *Generators*) on a sent out basis for the *Market Customers* of a *Generator* (other than Territory Generation) in any one *settlements period*.

ASPrice = $5.40/MWh (sent out) unless the *Market Operator publishes* a notice amending this price

(c) The *Market Operator* is to determine the ASQuantity as specified in subclause A6.11(b) in accordance with a method contained in a document prepared and duly approved by the relevant *Generators*.

(1) The method specified in this subclause is to be acceptable to the *Market Operator,* whose acceptance cannot be unreasonably withheld.

(2) The document specified in this subclause may be amended from time to time by the *Generators* in accordance with a process agreed by the relevant *Generators*.

(3) The detailed workings in determining the ASQuantity for each *settlements period* are to be made available to the affected *Generators*.

(d) The affected *Generators* are to provide within two *business days* after the end of the *settlements period* the *Market Operator* with sufficient information per *trading interval* in order to determine the ASQuantity.

(1) The *Market Operator* must provide the *Statements of Calculation* to the affected *Generators* within five *business days* after the receipt of the information provided in subclause A6.11(d).

(e) The information calculated in accordance with subclauses A6.11(b) and (c) is to be provided to the relevant *Generators* in the form of a *Statement of Calculation*.

(f) After receipt of a *Statement of Calculation* for a *settlements period*, a *Generator* in surplus must issue an invoice to the *Generator* in deficit for the amount stated in the *Statement of Calculation*

(g) The *Generator* that receives an invoice under subclause A6.11(f) must pay the invoice within thirty calendar days of the date of the invoice.

(h) A *Generator's* right to be paid or credited an amount in an invoice issued in accordance with this subclause A6.11 is enforceable between the relevant parties as a contract.

A6.12 *MARKET INFORMATION*

The *Market Operator* must *publish* the following information as soon as reasonably possible:

(a) *Market Price* for each *trading interval* for the previous *trading day*, or otherwise when available in accordance with clause 4.8(f);

(b) *Monthly* market volume weighted *Market Price* for the *peak period* and *off-peak period*;

(c) *Pre-dispatch schedule* for the previous *trading day*;

(d) Actual dispatch schedule for the previous *trading day*;

(e) Actual *constraints* for each *trading interval* in the previous *trading day*;

(f) Total system demand for each *trading interval* in the previous *trading day*.

(g) The results of the comparison determined in accordance with clause A6.5(c).

ATTACHMENT 7 OUT OF BALANCE WITHIN TENNANT CREEK AND *ALICE SPRINGS POWER SYSTEMS*

This Attachment 7 applies only in respect of the *Tennant Creek power system* and the *Alice Springs power system*.

A7.1 Pricing objectives

When determining guidelines or dispatch arrangements which may affect the prices for any *out of balance energy* services, the Utilities Commission and the *Power System Controller* must ensure that these guidelines and arrangements result in prices which best promote:

(a) the efficient provision of out of balance capacity and *out of balance energy*; and

(b) the efficient operation and ongoing development of a *power system* as a whole.

A7.2 Settlement of *out of balance energy* services

(a) A *Generator* that produces an amount of *energy* different to its *Market Customers'* demand in an *energy usage period* must pay to the *Generator* or *Generators* responsible for providing or purchasing the *energy* difference an amount equal to the product of:

(1) the applicable system imbalance *energy* price; and

(2) the difference between the actual and required amount of *energy*.

(b) Where any *out of balance energy* is produced by *generating plant* in excess of the *plant* necessary to meet the *Generator's* own aggregate *Market Customer load*, the *Generator* that produces less than its *Market Customers'* demand must pay to the *Generator* or *Generators* responsible for providing the necessary additional *generation* capacity an amount equal to the product of:

(1) the applicable system imbalance capacity price; and

(2) the additional *generation* capacity involved.

(c) The *Power System Controller's* assessment of the *out of balance energy* supplied or demanded by a *Generator* must take full account of *network losses* where such losses are:

(1) estimated in accordance with clause A7.5; or

(2) as otherwise determined from time to time by the *Power System Controller*.

(d) The system imbalance prices are to take into consideration:

(1) the type of out-of-balance transfer involved;

(2) the magnitude of the loading or deloading of *generation plant* providing the *out of balance energy*; and

(3) the *time* of *day*, *day* of week and season of the year in which the *out of balance energy* service provision occurred.

(e) Procedures for the settlement of any out of balance virtual payments between the *Generators*, and the role to be played by the *Power System Controller* in the settlement process:

(1) are to be developed by the *Power System Controller* in consultation with licensed *Generators*; and

(2) are subject to the approval of the Utilities Commission.

(f) The Utilities Commission must approve the procedures developed under subclause A7.2(e)(1) only if the Utilities Commission considers the procedures to be consistent with the pricing principles in clause A7.1.

(g) The means of establishing the system imbalance prices referred to in this clause are set out in clauses A7.3 and A7.4.

A7.3 Determination of the system imbalance *energy* price

(a) The system imbalance *energy* price to apply in a particular *energy usage period* will depend upon whether or not dispatch of *generating units* is affected by system *constraint* or system security considerations.

(b) In circumstances where dispatch of *generating units* is unaffected by system *constraint* or system security considerations, the system imbalance *energy* price is to be defined by reference to the marginal operating costs of *generating units* instructed by the *Power System Controller* to deviate from their expected level of output.

(c) In the circumstance applying under clause A7.3(b), the price must be either:

(1) the highest marginal operating cost of any *generating unit* instructed to increase output, in the event that additional *supply* is required; or

(2) the lowest marginal operating cost of any *generating unit* instructed to decrease output, in the event that the market is oversupplied.

(d) Where system *constraints* or system security requirements affect the dispatch of particular *generating units*, the *Power System Controller* is to both:

(1) instruct the dispatch of *generating units*; and

(2) set the associated system imbalance *energy* price, in accordance with *constraints* management and system security procedures approved by the Utilities Commission.

(e) In approving the procedures authorised under clause A7.2(e), the Utilities Commission is to ensure that the procedures and associated pricing are, in the Utilities Commission's opinion, as consistent as is practicable in the circumstances with the efficient operation of a *power system*.

(f) For the purpose of this clause, *Generators* that are on *load* following duty are deemed to be instructed.

A7.4 Determination of the system imbalance capacity price

(a) The system imbalance capacity price to apply in a particular *energy usage period* must be defined by reference to the incremental capital cost of *generating units* instructed by the *Power System Controller* to commence output.

(b) The price must be the highest incremental capital cost of any additional *generating unit* instructed to commence output, in the event that additional *supply* is required.

(c) For the purpose of this clause, *Generators* that are on *load* following duty are deemed to be instructed.

A7.5 *Energy loss factor* formula

(a) The *energy loss factor* for a *connection point* is the factor established by the *Network Operator* pursuant to the *Energy Loss Factor Code*.

Review of the Northern Territory Generator Performance Standards

Appendix D
Responses to Stakeholder Submissions

PowerWater

APPENDIX D. RESPONSES TO STAKEHOLDER CODE CHANGE SUBMISSIONS

Responses to Power and Water's Proposed Code Clause Changes and June Consultation Paper

The following table outlines our responses to the issues raised by stakeholders in the second round of consultation.

Please note the issues column are in general our summarised interpretation of the issues raised by stakeholders rather than a verbatim quote from individual submissions. The submissions are available on our website (other than those identified as confidential). The Power and Water Ref# is an internal issue tracking number to ensure all issues raised have been addressed. For confidential submissions containing detailed questions, Power and Water are contacting the stakeholder directly to provide responses. A summary response is provided in the 'Power and Water response' column, however further detail on most issues is available within the body of the application. Where further detail is available the relevant section reference has been provided.

The general headings under which comments are grouped in the table below are:

1. **Divergence from NEM / WEM models for NT**
2. **Least cost solutions – assertions regarding costs and benefits**
3. **Grandfathering, transitioning, staged implementation**
4. **Centralised (system control) vs decentralised forecasting and firming**
5. **Insolation vs. capacity**
6. **Behind the meter arrangements**
7. **C-FCAS and forecasting interactions (i.e. battery response)**
8. **Forecast non-compliance**
9. **Stakeholder initiated rule change process**
10. **Roadmap to Renewables / NTEM / GPS alignment**
11. **Other matters raised**

NOTE – [redacted] indicates a confidential submission.

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
D.1	Why NEM / WEM isn't appropriate				
1	Cost of divergence	Climate Action Darwin	Asserts that costs too high; GPS more onerous than for east coast and WA markets;	Important differences between the NT, NEM and WEM have been documented, and confirmed in other consultation documents.	Sections 2.5 and 7.2.2 in this application.

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
		[redacted]	requirement for variable large scale solar to be fully dispatchable is impractical and anticompetitive. Significant disincentive for renewable investment impedes modernisation and diversification of Territory power supply.	Recognising that divergence from NEM or WEM requirements can create challenges for generators and generator proponents, our GPS development approach has adopted new standards based on the equivalent NER Chapter 5 Schedule 5.2 requirements, except where adoption in the NT would prevent System Control having the necessary levers of predictability and dispatchability to ensure power system security in the NT power systems. These requirements are achievable, but non-standard. However, in terms of system management that aligns with the objective of high renewable penetration up to 100% of demand at some periods, it is definitely a practical requirement. These requirements are not anti-competitive - they facilitate competitive tension by all technologies to compete equally in the energy dispatch arrangements. The alternative is anti-competitive as a portion of energy delivery would have to be reserved for traditional generation.	
50	NT vs. NEM reliability	Proa Analytics	Observation - Power systems of the size of the NT would certainly need greater reliability requirements than a system such as the NEM	Power and Water agrees with this observation.	
39 **74**	Divergence from NEM/ WEM	NT Solar Futures	Calls for semi-scheduled generator classification to be retained to facilitate intermittent renewable energy generation. Asserts a significant technical and cost burden on (new) intermittent renewable energy to meet the Code. Asserts it makes the NT market more onerous than the NEM and WEM and will stifle investment in the NT.	The NT market is technically different to the NEM and the WEM. The connecting generators are significantly different in relative size when compared to the NEM and WEM. A 30MW generator scaled by DKIS peak demand against the peak demand in the NEM would be a 3,300 MW generator (660 times larger than the NEM small generator exemption threshold). For generators of equivalent relative size on the WEM or the NEM, the generator classification imposed may well be scheduled, so it is not entirely inconsistent as presented. Furthermore, these have markets to manage the intermittency, the GPS provide a framework that allows for appropriate cost allocation and the generator	Sections 2.5 and 7.2.2 in this application. Further transitional derogations included in NTC clause 12.

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
			Asserts reviews put the NT at a technologically theoretical position, well in advance of the proven approaches of other jurisdictions including the NEM and WEM.	capabilities that would be necessary for operation with 100% of demand supplied by solar PV at some periods of the day. Power and Water recognise that divergence from NEM or WEM requirements can create challenges for generators and generator proponents. Our GPS development approach has therefore been to adopt new standards based on the equivalent NER Chapter 5 Schedule 5.2 requirements, except where adoption in the NT would prevent System Control having the necessary levers of predictability and dispatchability needed to ensure power system security in the NT power systems.	
57	Removal of semi-scheduled generator classification	Territory Generation	Asserts that 'one-size-fits-all' places unnecessary obligations on both thermal and large scale solar PV	The same capabilities have always been necessary from synchronous generation, albeit the form differed. For instance, capacity information is typically provided as a static figure from a synchronous generator, which could be done within the forecasting framework at negligible cost. In these reforms, Power and Water has sought to remain technology agnostic. Application of the NER to the NT must be tailored to the specific conditions here. Generator classification required recognition that the NEM is a much larger electricity market than the NT market, with a larger diversity of fuel sources, generation types, and geographical distribution. The NT's extremely small power systems will rapidly move to the point where renewable generators represent a majority of the generation producing at certain times. The 'semi-scheduled' status in the NEM reflected the historically 'new entrant' and marginal nature of NEM renewables. In a maturing renewable industry, with the central role it is being called on to play in meeting the energy demands of the NT power systems, it is not appropriate to maintain this distinction. The distinction only works when asynchronous renewables are not a material share of the generation pool. In effect the 'semi-scheduled" status pushes the risk of generation not performing in	June Consultation Paper, section 4 Sections 2.5 and 7.2.2 in this application.

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
				the manner forecast to the power system as a whole. This outcome would lead the costs of addressing this to be borne by those who are not causing it, whereas our analysis suggests that generators have access to the least cost ways of addressing it and our proposal places the responsibility with them to do so.	
D.2	Least cost solutions – assertions regarding costs and benefits				
[redacted]	[redacted]	[redacted]	[redacted]	The modelling Power and Water undertook sought to maintain current system security levels in the least cost approach. It is Power and Water's view that the proposed amendments achieve the least cost outcomes across all aspects of electricity supply for customers.	Sections 2, 2.4.2 and 2.4.6 in this application.
[redacted]	[redacted]	[redacted]	[redacted]	The wording in the engagement question caused confusion. It should have read "all generators should have the C-FCAS capability necessary as a safety net". As previously advised throughout the consultation process, Territory Generation is the primary provider for ancillary services. In dispatch, this means that where a generator has its energy production curtailed to provide C-FCAS, Territory Generation units are curtailed in preference to other generators. Although the dispatch principles remain unchanged, Power and Water have proposed an amendment to SCTC section 4.3 that clarifies ancillary service dispatch principles.	Sections 2, 2.4.2 and 2.4.6 in this application.
62 (=3)	General comments - transition, exemptions	Tetris Energy	Calls for Power and Water to "[focus] on lowest cost options initially, reviewing the GPS framework as necessary for future connections, in step with technological developments. This facilitates the impending investment and provides transparency and flexibility for future refinements." Wants the code to be started	Power and Water has set out the generator performance standards based on the required capability generators must have when connecting to maintain existing levels of system security in future operating arrangements. Although this is a greater expense to some connecting generators, it is a lower cost to the consumers, who would pay for additional security reserves to accommodate intermittency or reliability issues with new generators as an ongoing expense. Furthermore, the framework specifies the technical requirements to be delivered rather than how these must be delivered. This	Sections 2, 2.4.2 and 2.4.6 in this application.

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
			with low requirements and then be increased.	allows technological developments to be accommodated in the connection process for generators connecting into the future.	
63	Increased project costs and grandfathering	Tetris Energy	Considers the anticipated increase in project costs of 20-30% creates a substantial investment risk. Calls to extend grandfathering - for projects that have signed and GUA and Power Purchase Agreement under the Jacana tender process.	The changes are necessary to ensure system security and reliability, and facilitate future renewable energy. All currently in-flight generators were advised of the upcoming GPS in early 2018, and given an early draft of the proposed changes. Grandfathering of these participants is not in the interest of the customers. Nevertheless, Power and Water has proposed modifications to clause 12 of the NTC to assist in-flight connections to achieve compliance	Section2 and 5 in this application NTC clause 12.3
61 **69**	Costs vs. benefits / risk mitigation	EDL, Tetris Energy	Assertion that costs of GPS reforms outweigh the benefits, that other (better) options exist, or that costs are not fully understood Assertion that a meaningful assessment of the net costs of the GPS changes doesn't appear to have been undertaken	The security standard in place currently of N-1 for credible contingencies is aligned with international practice. As such, the generator performance standards were assessed on a basis of 'least cost to maintain security' rather than a formal cost benefits analysis where the loss of customer load would be valued. Feasibility and availability of solutions was tested and confirmed.	UC application: Least cost vs. costs benefit - Sections 2, 2.4.2, 2.6
D.3	Grandfathering, transitioning, staged implementation				
3	Staged implementation	Assure Energy,	Advocates amendments for "a commercial, feasible and deliverable framework that can evolve as the system, generation and technology improves" involving a trial, other measures	A trial assumes that there would be a relatively slow take up of PV generation. Considering the existing applications, Power and Water do not think this is feasible. The alternative option that was considered was whether the obligations could be staged, however it was found that this was likely to significantly increase the cost of connecting future generators as the obligations would need to be significantly increased in comparison to those applied to early movers; or if the current obligations applied to all. It is technically and commercially feasible based on Power and Water's analysis of the capabilities of insolation forecasting and	Section 5 in this application Further transitional derogations included in NTC clause 12.

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
				storage technologies to meet the proposed forecasting requirements. This was supported by Entura in their report attached to the consultation documents. Nevertheless, transitional derogations for in-flight generators have been reviewed, and new provisions added to enable a transition to full compliance.	
12	Grandfathering - interpretation	Darwin International Airport	States its understanding to be that: - all installations currently grid connected at the time of enactment will be grandfathered with no additional requirements for the life of the plant; and - connection applications submitted before the time of enactment will also be grandfathered	The interpretation is not correct. Grandfathering applies only to existing connected generating systems that were connected to the Power and Water network prior to 1 April 2019. Generators connecting after 1 April 2019 will need to meet the new NTC once approved by the Utilities Commission. However, new provisions have been added to NTC 12.3 to provide a grace period for certain technical requirements, for connections that occur between 1 April 2019 and the date when code amendments commence. In general, modifications or alterations to generating systems fall under Chapter 5 of the NT NER require that the modification or alteration results in the generating system meeting or exceeding the technical standards that are referred to in the connection agreement between the Network Operator and the generator.	Section 5 in this application Further transitional derogations included in NTC clause 12.
15 [redacted] **63**	Grandfathering/ staged implementation	Tetris Energy, Darwin International Airport [redacted]	Call to further extend grandfathering - for projects with signed agreements. Advocates a phased approach to implementing forecasting for dispatch in both forecast length and accuracy to lessen the compliance burden of such a significant change/rollout	Transitional derogations for in-flight generators have been reviewed.	Section 5 in this application Further transitional derogations included in NTC clause 12.

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
34	Transitioning and sequencing	NT Solar Futures	Suggests that the long term perspective adopted in the codes is premature.	The code changes leverage robust engineering work that is in practice with respect to active power management and forecasting. Although this is cutting edge work with respect to the extent of the obligations, the tools and combinations of technologies such as insolation forecasting and energy storage are both established, proven technologies. An isolated regulated power system operating with the levels of highly variable renewable energy that are currently in application for the DKIS is theoretical and significantly beyond the experience of other jurisdictions. Power and Water are ahead of other jurisdictions in this regard, and cannot wait for them to resolve the challenges. Inaction will impact our security and reliability of supply.	Section 2.5 and in 7.2.2 in this application
70	Process to demonstrate compliance	EDL	Noted T-Gen's concern in earlier consultation re lack of detail on the process to demonstrate compliance of plant modifications. Supports codification in the NTC of the process described in the workshop.	NT NER provisions (notably clause 5.7.3) now set out the process. A separate process has also been added for transitional derogations and compliance following a grace period in NTC clause 12.	Section 6.2 in this application NT NER clause 5.7.3
55	Grandfathering and SCTC	Territory Generation	Advocates adding grandfathering provisions to SCTC - to cover all changes that affect existing generators	The SCTC covers operational matters relating to market operations and system security. It would not be appropriate or consistent with the code change requirements to grandfather other provisions of the SCTC. An exception was made with regards to the cost allocation for the nomenclature changes, as those are discretionary arrangements made by the Network Operator.	Section 5 in this application Code change processes in clause 1.8.2 of the SCTC

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
D.4	Centralised (system control) vs decentralised forecasting and firming				
10	Centralised (system control) vs decentralised forecasting and firming	Darwin International Airport	Cost of battery installation within a solar field. Whether cost of cooling has been included using NT meteorological data. Challenges assumption that all existing solar inverters can be used as battery inverters, and that this functionality comes at no cost	The intent is to allow for innovation and least cost outcomes with obligations that can be met under multiple technical solutions. The obligations are technology agnostic. The GPS does not include a battery requirement, it has a capacity forecasting accuracy requirement that could be achieved by use of a battery (amongst other options). Our cost estimates for achieving this on a solar PV site are well based conventional approaches, but are only indicative estimates. No statement was made that existing solar inverters can be used as battery inverters. It was mentioned that (with the correct selection of inverter) the same inverter could be used for solar PV battery combinations and that this comes at less cost than two separate inverters.	Section 6.2 in this application
33	Renewable Energy Roadmap - alignment	NT Solar Futures	GPS proposal is not least cost for NT electricity customers - lower cost alternative solutions exist Asserts the Roadmap "suggested that solar generators move towards dispatchability based on market signals (and not have this forced upon them now by the NTC)". Several of the proposed changes do not support a renewable future at least cost.	If there are lower cost alternatives to active power management (capacity forecasting/firming at the point of connection) they are not prohibited by the GPS framework. The rule changes provide a framework for entrant renewable energy generators to invest in the least cost options that maintain existing levels of system security (rather than at the detriment of system security).	See comments regarding least cost solutions in section 2 of this application
40	Centralised (system control) vs decentralised forecasting and firming		System Control are best placed to manage this risk on behalf of all generators and loads. Placing all the onus onto generators will lead to high cost RE generation and considerable over-build in	System operators are not best placed to manage the intermittency on behalf of all generators. In fact, there is significant pressure in the NEM with the trial of self forecasting for participants to have this responsibility as they have the best information on their plant. Furthermore, a central management balancing requirement could	Section 6.2 in this application

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
			capacity vs central provision of solutions	be proposed by entrant generators if it were a more efficient means of meeting the forecasting obligations.	
41	General comment - assumptions relied on	NT Solar Futures	Challenges Entura analysis, availability of DC-DC converters, assertions re cost of batteries installed centrally	If there are lower cost alternatives to active power management (capacity forecasting/firming at the point of connection) they are not prohibited by the GPS framework. The rule changes provide a framework for entrant renewable energy generators to invest in the least cost options that maintain existing levels of system security (rather than at the detriment of system security).	Section 6.2.2 in this application
56	Capacity firming or balancing services	Territory Generation	Challenges expectation on generators to find innovative solutions. Seeks listed clarifications from Power and Water including related actions by Power and Water, how technical implementation would occur, impacts on ancillary service arrangements, handling within control system, and more.	Power and Water considers that the approach is appropriate and aligned with relevant statutory objectives. The generator performance standards provide an outcome that is expected to be delivered for automatic compliance, alternatives require negotiation. The ability to negotiate an access standard enables innovation and least cost outcomes and the obligations can therefore be met under multiple technical solutions. These would require a specific proposal from the generator proponent put forward in the generator connection process.	
[redacted]	[redacted]	[redacted]	[redacted]	A generator that may be considered small in the NEM (e.g. the 5MW generator classification threshold used in the NEM to exempt small generators that have no significant impact to power system security) represents a significant percentage of the daytime demand in the DKIS. A 30MW generator scaled by DKIS peak demand against the peak demand in the NEM would be a 3,300 MW generator (660 times larger than the NEM small generator exemption threshold). It would also be approximately 4.4 times larger than the largest individual generator in the NEM. One such generator sized at 30MW would meet 30% of the minimum daytime demand in the DKIS. Geographical dispersion clearly does not minimise risks for generators of this size; when an individual variation of	

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
				approximately 80% of output could have similar impact to a generator trip event. Geographic dispersion is also limited in effect when generators are concentrated in the area of greatest solar resource and co-incident cloud cover events are not independent.	
D.5	Insolation vs. Capacity				
2	Forecasting feasibility	Assure Energy	Accuracy and forecasting is not achievable - While, the technology of forecasting remains nascent and will improve over time with greater experience and implementation, the physics, technology and systems currently available to provide this forecasting accuracy 30 minutes out from dispatch is not available at this time. Power and Water should lead the aggregate modelling on longer forecasts.	This concern appears to relate to insolation forecasting providing the entirety of the forecast, rather than in combination with any other technology. Insolation forecasts are only able to predict (to a reasonably high level of accuracy) the incoming energy, not the capacity (which is the power that can be continuously delivered over a period of time). It is technically and commercially feasible based on Power and Water's analysis of the capabilities of insolation forecasting and storage technologies to meet the proposed forecasting requirements. This was supported by Entura in their report attached to the consultation documents. Forecasting involves knowledge of individual sites that Power and Water are not privy to, and Power and Water will never be able to provide forecasts better than individual proponents.	Section 6.2.4 in this application
49	Forecasting feasibility	Proa Analytics	Observations: Commercially available state-of-the-art forecasts will substantially assist generators to meet requirements Even perfect forecasts would not remove the need for dispatchable compensating technology	Noted, this aligns with our modelling and the report by Entura, where some firming support (battery or otherwise) was considered likely to be required.	
64	Forecasting feasibility	Tetris Energy	Disparity between available forecasting technology and GPS forecasting requirements	Power and Water note our modelling undertaken and outlined in the main consultation paper, which showed that a 50% POE	June 2019 Consultation

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
			Solar forecasting - Power and Water should modify the proposed forecast to 50% probability of exceedance (POE) forecasts, with a pre-determined maximum and minimum bound.	forecast with tight error bounds causes large errors that would result in significant additional security reserve being held.	Paper section 3.1.3, also p37
D.6	Behind the meter arrangements				
4	Specific questions on detail	Assure Energy	Q1. If Embedded Generators are not exporting to the grid, since only a net load will be visible to the Power and Water System what are expected to be the dispatching arrangements in this regard (noting an embedded generator that is not exporting to the grid can only dispatch up to the total load)? Q2. Also – Clarification sought re ramp rate controls under Class 4 embedded generator requirements	As stated at the workshop, all generators greater than 2 MW even if 'behind the meter' will be required to meet the GPS and as such will be classified as scheduled generators and need to meet capacity forecasting requirements. Dispatch arrangements will be the same regardless of the load. The complexity is introduced in the capacity forecasting where an export limiter is in place. The forecast will be assessed on the capability of the generating system to continuously deliver active power up to the forecast capacity (gross production capability). As such, if it is under any practical restriction as part of the connection arrangements (such as an export restriction or plant thermal limits), this must be taken into account in the forecast. Power and Water believe that export limit arrangements are unlikely to be adopted by GPS scale generators in the future. Power and Water will consider other specific proposals in-line with the objectives of the forecasting requirements. Ramp Rate Controls are not required for plant under the GPS, this is included in the forecasting arrangements.	Section 6.2 in this application
[redacted]	[redacted]	[redacted]	[redacted]	See comments in row above. Addressed in discussions directly with stakeholder, and through greater clarity on transitional derogations and negotiated access standards.	Section 5 in this application NTC clause 12 NT NER Chapter 5

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
11	Embedded loads	Darwin International Airport	Asserts that Codes do not address installations with embedded loads, particularly sites with large variable loads, in relation to forecasting accuracy and export/import at connection point.	Power and Water believes that the arrangements do provide sufficient flexibility for such installations, noting the firming opportunity with control system and non-critical loads (e.g. HVAC short term cycling) See comments in the two rows above.	
D.7	C-FCAS and forecasting interactions (i.e. battery response)				
[redacted]	[redacted]	[redacted]	[redacted]	For all generator non-compliance instances, Power and Water will proactively work with the generator to minimise the level of constraint whilst maintaining system security. Codifying constraint arrangements for non-compliance would likely result in less efficient outcomes for all parties. A capacity forecast will not be constrained in a punitive manner, rather it will be to the level required to meet the GPS requirements. Specific detail cannot be given without specific information with respect to the nature of the error. Noting the maximum allowable error of 5%, a forecast that was 15% out would likely trigger a constraint process; without any knowledge of the cause the constraint would likely be to operate to 10% below the received forecast. Information received from the participant regarding the nature of the error and mitigating actions could likely result in removal of the constraint or less conservative constraint.	
5	Other specific questions – C-FCAS droop	Assure Energy	If a battery normally operated to firm the dispatch from a PV generator to meet its capacity offer / dispatch target is drained through providing C-FCAS, it will no longer have the floor room needed to provide this firming service. How would any failure to meet dispatch accuracy	The C-FCAS capabilities can be achieved subject to plant operational limits. It is clearly an operational limit that the battery state of charge remains within appropriate bounds to support any firming and forecasting requirements in 3.3.5.17. Therefore, with appropriate control of the battery it would maintain adequate state of charge to deliver the forecast capacity at all times.	

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
			requirements be treated in this scenario where C-FCAS has drained the battery to the detriment of firming capacity?		
8	C-FCAS - from battery and solar PV	Assure Energy	The current framework for capacity forecasts does not appear complete to enable recognition of C-FCAS capacity availability from both battery and solar PV elements. Can the intention be clarified going forward?	The requirement for C-FCAS capability is that the generating system (which can be comprised of a battery and solar PV elements or anything else), must be capable of providing a level of C-FCAS subject to the capacity of the plant at the time. The C-FCAS accreditation for each generating system is a function of the operating level of the generating system as a whole and its available capacity at that point in time. As both of these quantities are known the C-FCAS capability is also known.	June Consultation Paper, section 5
67	C-FCAS/inertia safety net	Tetris Energy	Treat different generators differently. Suggest that conventional generators provide FCAS and C-FCAS raise services in the market as a cost pass-through and renewable generator provide C-FCAS lower services.	The wording in the engagement question caused confusion. It should have read "all generators should have the C-FCAS capability necessary as a safety net". As previously advised throughout the consultation process, Territory Generation is the primary provider for ancillary services. In dispatch, this means that where a generator has its energy production curtailed to provide C-FCAS, Territory Generation units are curtailed in preference to other generators. Although the dispatch principles remain unchanged, Power and Water have proposed an amendment to SCTC section 4.3 that clarifies ancillary service dispatch principles. Power and Water agrees that the least cost sourcing of energy and all ancillary services (provision) is appropriate. This is consistent with the long term NTEM design objective for least total cost of electricity inclusive of energy and ancillary services.	
D.8	Forecast non-compliance				
72	Ancillary services	EDL	If the System Controller can de-rate a generator's dispatch where it has failed to meet the required capacity forecasting accuracy, in	This consultation does address the design of the NTEM and possible future capacity markets. However, in terms of how decisions will be made around derating, Power and Water note as follows.	

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
			the absence of details of the specific trigger for that decision or nature of the derating process, are provided, concern is that this may serve as a disincentive to generators offering capacity contracts.	A capacity forecast will not be constrained in a punitive manner, rather it will be to the level required to meet the GPS requirements. Specific detail cannot be given without specific information with respect to the nature of the error. For example: noting the maximum allowable error of 5%, a forecast that was 15% out would likely trigger a constraint process; without any knowledge of the cause the constraint would likely be to operate to 10% below the received forecast.	
D.9	Stakeholder initiated rule change process				
54	SC forecasting obligations	Territory Generation	(Repeated) - Proposes extension of forecasting obligations on Power System Controller (drafting set out in their Attachment A)	Future code changes will be considered. A streamlined approach for addressing future code changes is set out in attachment to the UC application. Power and Water will request further information on this proposed change to cover the specified SCTC content (i.e. impact on participants). This will be collated in a consultation package with the other proposals for further code reviews.	Section 2.3.2 and Attachment A to this application
D.10	Roadmap to Renewables / NTEM / GPS alignment				
36	NTEM integration	NT Solar Futures	Asserts that NTEM and GPS reviews not co-ordinated - co-operation is necessary for a coherent NT electricity industry	The majority of the generator performance standards are unrelated to market reform as they relate to the adequate performance and capabilities of generators. This ensures plant operates in a stable manner and there are appropriate security reserves to call upon. However, Power and Water continues to work with the Department of Treasury and Finance in the GPS development to ensure alignment with the NTEM design.	
73	NTEM integration	EDL	Crucial that the GPS and NTEM processes deliver a well-integrated set of market arrangements to help secure the Government's policy objectives.	See response in the row above.	

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
68	Renewable Energy Roadmap - alignment	Tetris Energy	The roll out of the new GPS should integrate with the Road Map to Renewables Policy	The Roadmap to Renewables report is a plan on how to deliver high penetration of renewables, not the objective. The generator performance standards as proposed facilitate high penetration of renewable energy generators into the energy supply industry at the least cost to consumers.	
71	Forecasting	EDL	We "strongly encourage PWC to consider the proposed changes to the forecasting framework together with the proposed changes to the NTEM dispatch arrangements. It would be inefficient and potentially costly to require two systems and/or having them misaligned."	The forecasting framework aligns with the proposed NTEM dispatch arrangements.	
45	Forecasting	NT Solar Futures	Too onerous on intermittent renewable energy generators. Without precedent, without operational experience to draw on. Practical workability uncertain. Adverse effect on investor certainty. Concerns with high probability of exceedance values, that will lead to significant under forecasting of actual renewable production, at times, in order to comply. Advocates NEM-type arrangement instead	A 15 minute ahead forecast is not adequate for system control purposes. Capacity forecasting is not simply solar forecasting, and cannot be accurately done by System Control. The trade-off on under forecasting or investment in firming arrangements (such as storage) is best situated with the generator as they have both the best information with knowledge of their plant and the incentive to optimise for lowest expense.	

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
D.11	Other matters raised				
53	Role allocation	Territory Generation	Not generator's role to report against revised GPS Onus should be on Power and Water, not TGen, to determine what gaps exists	It is currently a generator's responsibility to undertake regular performance tests to demonstrate compliance with the Network Technical Code. This remains unchanged, however in the interest of transparency Power and Water has indicated that the results of this testing will be used for the documentation of the grandfathered compliance.	
37	New obligations on System Control	NT Solar Futures	(Repeated comment) - Seeks obligation on System Control to maximise renewable energy Comment repeated in relation to dispatch under cl 4.3 - seeking that focus not be on system security and reliability to the detriment of renewable energy	The Codes must reflect the underlying legislative framework, including the rights, obligations and objectives of market entities. This proposal is inconsistent with the framework governing the system control function, and paramountcy of the system security requirements. Power and Water believes that the proposed inclusion would require government policy and legislative changes. Round 1 response flagged that this was an issue that would need to be taken up with government.	June Consultation Paper, Appendix A.4
38	New obligations on Network Operator	NT Solar Futures	(Repeated comment) - Seeks obligation on Network Operator to maximise renewable energy	As above	
9	General comments - transition, exemptions	Darwin International Airport	Solar installations spread over multiple buildings and over a wide area, giving inherent diversity to clouding, appear to be negatively impacted by the cost of multiple forecasting systems being required. A relaxation of forecasting accuracy is suggested for mitigation.	If multiple forecasting systems are required, it suggests that multiple sites are different. There is no automatic reason for assuming that the diversification will work in their favour. Assuming the diversification factor did flatten out the peaks and troughs in PV production, this would assist in the process of converting an insolation forecast to a capacity forecast which may offset the costs in multiple forecasting systems.	

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
13	Evidence relied on	Darwin International Airport	Asks Power and Water to publish solar forecasting data and approved vendors/systems which were tested during Power and Water's evaluation of vendors. Additionally, request time to review and evaluate such systems.	The underlying data is commercial in confidence and Power and Water does not have authority to publicly distribute it. However, Power and Water had the analysis independently verified by Entura and is willing to share this with the UC if required. There are a number of insolation forecasting providers that are available to contract, Power and Water reviewed data from two of these providers and would recommend that industry participants undertake their own due diligence when selecting their preferred solution and vendors. Note, Power and Water has added 'grace period' provisions in NTC clause 12	Revisions to NTC clause 12.3
14	Technical assumptions	Darwin International Airport	Seeks "recognition that the requirement for 39.5% of nameplate active power to be available for reactive power support comes at the cost of active power capability and for a mechanism to be remunerated upon the establishment of a market for such services".	This requirement is consistent with the NEM. The requirement maintains the balance of reactive power support between generators and network. There is not a market framework in the NEM to renumerate for this and it is reasonable to expect that the NT will not adopt more complex market arrangements than the NEM. Further information from AEMO regarding the application of reactive power requirements is available on AEMO's website	https://www.aemo.com.au/-/media/Files/Electricity/NEM/Network_Connections/Transmission-and-Distribution/Clarification-of-S525-Technical-requirements.pdf
52	Consultation	Territory Generation	Process criticism – Asserts issues raised not tracked; justification for proposed changes not clear	In developing the consultation material for the second round of consultation, the response to all issues were tracked internally. Any issue without a specific reference in an appendix was addressed in the body of the main consultation document as a consolidated response to common themes was more appropriate than individual comments to repeat issues. Power and Water have adjusted our approach to improve readability in this round.	

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
				If further clarification is sought, Power and Water can provide references offline.	
46	Active Power Control - ramp rates	NT Solar Futures	(Repeated comment) - Ramp rates should be set on a MW basis or % of name plate rating per minute basis for semi-scheduled and/or non-scheduled generation. The present minimum ramp rate of 5% per minute is onerous for intermittent renewable energy generation. Minimum ramp rates will be taken into account when determining the solar farm yield and hence will increase energy prices or decrease financial viability. More appropriate minimum ramp rates should be specified.	The comments suggests some misunderstanding, implying that GPS set operational arrangements, rather than the minimum capability. Within the GPS, the ramp rate specified is the minimum (slowest) technical capability on the inverter; it does not specify how the plant will be operated. All inverters can achieve this capability out of the box; the requirement is not considered onerous for intermittent renewable energy generation. If the plant has faster capability it can be operated to that level subject to system requirements. This obligation is intended to ensure that generators who have very slow response capabilities must meet a minimum capability to connect.	
16	Classification - batteries	Darwin International Airport	Must recognise different modes of operation for batteries so the functions used for ancillary services can be realised in the electricity market. By classifying a battery as a generator only, this reduces the incentive to invest in the installation of batteries; making solar generator output reductions from forecasting systems more likely. This is counter to the accepted knowledge that more storage on the grid will enhance system security and stability	The generator performance standards were never set out to be the connection standards that facilitate entry of any and all equipment onto the power system. Power and Water have not yet set out to develop performance standards for equipment that is not performing the traditional role of a generator; provision of energy. However, as Power and Water have not provided a specific framework for batteries, under the existing framework a battery would be held to the relevant connection requirements for both generators and loads. The NEM are currently working through rule change proposals for battery connection requirements. The outcomes of this will be followed and considered by Power and Water.	Table only

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
44	Classification - none for batteries/ storage	NT Solar Futures	Should be considered, as for NEM	As clarified in the first consultation, batteries will be considered as both a load and a generator at this point in time. This is consistent with the NEM. Power and Water will monitor how this unfolds in the NEM in regards to a special class of connection.	
59	Classification - ancillary service provision	Territory Generation	Specific examples given of assets used in provision of ancillary services that should not be captured by GPS obligations	The code changes to introduce the GPS did not set out to resolve every issue with the technical codes. For technologies operating in different arrangements such as batteries or flywheels for ancillary services, it would have to be considered against the generator and load connection requirements as it both consumes and delivers power. If there is a provision that is not relevant negotiation is appropriate or if there is another technical matter needed to be coordinated, this will also be highlighted in the connection process. Additionally, Power and Water are monitoring the outcomes of the NER changes for battery classifications.	
47	Definitions / nomenclature	NT Solar Futures	The inertia definitions are restricted to electro-magnetically coupled equipment. These narrow definitions exclude Synthetic Inertia (also known as Virtual or Digital Inertia). The definition should be expanded to include equivalent system services that can be provided by synthetic inertia such as battery inverters. This service has been available and provided by battery inverters for several years now. ...The inclusion of synthetic inertia into the code will enable new generators to meet the grid code requirements more cost effectively.	The inertia definitions are restricted (by default) to electro-magnetically coupled equipment as that is the only equipment that does provide the same service. In the DKIS, the fast response from inverters described as 'synthetic or digital inertia' as presented in the reference material would be accredited towards achieving the performance standards as C-FCAS not inertia. However, NTC 3.3.5.15 (a) (2) provides the ability for 'emulated' inertia sources to be considered: "Inertia offered or provided from non-synchronous (emulated) sources needs to be assessed and accepted by the Power System Controller and Network Operator." The reference material provided to support the points that synthetic inertia is equivalent are not applicable for various reasons: - Alinta is a common bus scenario and therefore not subject to the complex control interactions from multiple separately located generation sources on a regulated network. This performance is	

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
				not achievable on a regulated system. - The Everoze study explained the key differences in a regulated power system: the inverters required a detuned response to mitigate control interactions, and thus for the 'synthetic inertia' to deliver any power it must leverage actual inertia for the first 0.1 to 0.2 seconds. Synthetic/virtual/digital Inertia is not the same as inertia as it required actual inertia to manage the RoCoF for the first 0.2 seconds before supporting.	
35	General comment - Evidence relied on	NT Solar Futures	Asserts that in the absence of a static and dynamic model (anticipated end 2019), it is not possible to look in detail at potential network, generation and load scenarios for what the system will look like in the future. Makes it difficult to plan for the future and set the Codes appropriately.	The development of the dynamic system model will assist in the management of significant penetration of renewables, primarily with respect to the dynamic electromagnetic transient responses of equipment. Although this work is an important tool for network planning and operational constraints, it does not prohibit the connection of renewable generators as scheduled over the next 12 months. Based on the experience of other jurisdictions it will have no material impact on the proposed generator performance standards.	TO
[redacted]	[redacted]	[redacted]	[redacted]	These proposals are at odds with the principles of open access arrangements and connection applicant rights underpinning the NT NER	
[redacted]	[redacted]	[redacted]	[redacted]	Power and Water agrees with the importance of inertia in the management of power system security. Future modelling work will need to be done here to guide future reforms as a matter of priority.	

PWC Ref#	Theme	Stake-holder(s)	Issue / comment	Power and Water response	References
51	Other comments - Rooftop PV forecasting	Proa Analytics	May help to increase the number of monitored rooftop PV systems in the NT networks	Power and Water agree with this comment and advise we are already investigating and investing in ways to improve forecasting of distributed energy.	
48	Test schedule	NT Solar Futures	Instead of a test schedule for inverter coupled solar generation, asserts it is better to have a starting point in the Code to reduce risk and costs to generators.	System control is currently working to provide a guideline for developing test plans, however due to the bespoke nature of every facility, it has to be with the generator to provide the test plan for their equipment.	
6	Power factor voltage control	Assure Energy	Seeking clarification of the intended operating mode for a behind the meter generator of > 2 MW (operating to supply a large customer).	Power and Water confirm that all generators including behind the meter >2 MW will be required to meet the GPS. The PV classification document is a subsidiary of the Network Technical Code. It will require an update following these proposed changes to the code.	

APPENDIX C. OVERVIEW LIST OF CODE CHANGES

C.1 Network Technical Code (NTC) amendments

Table 1 – Amendments to NTC (draft as at 29/8/19)

NTC Clause	Description of proposed amendment
Part A	**Legislative requirements** Changes reflect amendments from 1 July 2019 to the governing Act and Regulations. The powers to amend NTC now reside in the Electricity Reform (Administration) Regulations. Figure 1 has been updated.
1.4	Provides for commencement of a new version of the NTC
1.7.3(a)(1)	Obligations of Generator Users: Editorial – reference to clause 3.2 deleted.
1.9	Code amendments - Paragraph (c) is made subject to paragraph (f). A new paragraph (d) allows for an extension of the 30 days to allow for required consultation
2.2.2	Update to refer to spinning reserve 'or C-FCAS as applicable in each regulated power system'
2.6.1	Transient rotor angle stability: Transferred to clause 3.3.5.5
3.2 opening paragraph	**Section 3 - Technical requirements for equipment connected to the network** In 3.2 – new introductory paragraph added to modify this clause to apply to network users other than Generator Users so that the GPS are all contained under clause 3.3.
3.3 (modified)	**New requirements for connection of Generators** Provisions replaced by those based on NER Schedule 5.2 'Conditions for connections of generators'. Opening paragraphs (a) to (f) replaced by a single summary paragraph.
3.3.1 (modified)	Outline of Requirements: Existing opening paragraphs (a) to (e) and sub-clause 3.3.1.1 on 'Protection requirements' replaced by the material provisions in NER S5.2.1. Paragraph (b) clarifies materiality thresholds where clause 3.3 applies.
3.3.2 (modified)	Application of settings: Existing opening paragraphs (a) to (e) and sub-clauses 3.3.2.1 to 3.3.2.11 on 'Technical characteristics' replaced by the material provisions in NER S5.2.2.
3.3.3 (modified)	Technical matters to be co-ordinated: Existing sub-clauses 3.3.3.1 to 3.3.3.6 on 'Monitoring and control requirements' replaced by the material provisions in NER clause S5.2.3.
3.3.4 (new)	Provision of information: Existing clause 11.3 'Information to be provided by Users with Generators' transferred to this location with suitable editorial adjustments to align with NER clause S5.2.4.
3.3.5 (new)	Technical requirements: Incorporate the provisions of NER clauses S5.2.5 & 5.3.4A (b1) & (b2) as new opening paragraphs. The majority of this clause provides clarity around the principles for proposing negotiating access standards for generators.
3.3.5.1	Reactive Power Capability: Incorporate the provisions of NER clause S5.2.5.1. automatic access standard.

NTC Clause	Description of proposed amendment
3.3.5.2	Quality of Electricity Generated: Incorporate the provisions of NER clause S5.2.5.2 automatic access standard with suitable amendments for the NT.
3.3.5.3	Generating Unit Response to Frequency Disturbance: Incorporate the provisions of NER clause S5.2.5.3 automatic access standard with suitable amendments for the NT.
3.3.5.4	Generating System Response to Voltage Disturbances: Incorporate the provisions of NER clause S5.2.5.4 automatic access standard with suitable amendments for the NT.
3.3.5.5	Generating System Response to Disturbances Following Contingency Events: Incorporate the provisions of NER clause S5.2.5.5 automatic access standard with suitable amendments for the NT.
3.3.5.6	Quality of Electricity Generated and Continuous Uninterrupted Operation: Incorporate the provisions of NER clause S5.2.5.6 automatic access standard with suitable amendments for the NT.
3.3.5.7	Partial Load Rejection: Incorporate the provisions of NER clause S5.2.5.7 automatic access standard with suitable amendments for the NT.
3.3.5.8	Protection of Generating Units from Power System Disturbances: Incorporate the provisions of NER clause S5.2.5.8 automatic access standard with suitable amendments for the NT.
3.3.5.9	Protection Systems that Impact on Power System Security: Incorporate the provisions of NER clause S5.2.5.9 automatic access standard.
3.3.5.10	Protection to Trip Plant for Unstable Operation: Incorporate the provisions of NER clause S5.2.5.10 automatic access standard.
3.3.5.11	Frequency Control: Incorporate the provisions of NER clause S5.2.5.11 automatic access standard with suitable amendments for the NT.
3.3.5.12	Impact on Network Capability: Incorporate the provisions of NER clause S5.2.5.12 automatic access standard.
3.3.5.13	Voltage and Reactive Power Control: Incorporate the provisions from NTC V3.1 clauses 3.3.3.5 & 3.3.3.6.
3.3.5.14	Active Power Control: Incorporate the provisions of NER clause S5.2.5.14 automatic access standard with suitable amendments for the NT.
3.3.5.15 (new)	Inertia and fast contingency FCAS: New clause requiring generator users to demonstrate the capability to provide a minimum level of inertia or contingency FCAS or a combination of both. Note the NTC only defines technical capability a generator needs to meet for connection and does not prescribe how generators are operated to meet power system security requirements.
3.3.5.16 (new)	System Strength: New clause to incorporate the provisions of NER clause 5.3.4B to ensure new generators are able to meet the agreed GPS and not adversely affect other Network Users.

NTC Clause	Description of proposed amendment
3.3.5.17 (new)	Capacity Forecasting: New clause requiring generator users to demonstrate the capability to provide capacity forecasts 30 minutes ahead to enable optimal economic dispatch of generators.
3.3.6 (new)	Monitoring and Control Requirements: Parent clause heading only
3.3.6.1	Remote Monitoring and Control: Incorporate the provisions from NTC V 3.1 clauses 3.3.3.1 & 3.3.3.2.
3.3.6.2	Communications Equipment: Incorporate the provisions from NTC V3.1 clause 3.3.3.3.
3.3.7	Power Station Auxiliary Supplies: Incorporate the provisions of NER clause S5.2.7.
3.3.8	Fault Current: Incorporate the provisions of NER clause S5.2.8 automatic access standard.
4	**Power System Operational Support:** Change in title from 'Power System Security' to remove clash with this title in the SCTC, to reflect Network Operator obligations in supporting the Power System Controller to manage power system security.
4.1	Introduction: Delete clause.
4.1.1	Purpose and application of clause 4: Delete clause.
4.2	Power system security principles: Delete clause.
4.2.1	Power system operating state: Delete clause.
4.2.2	Technical envelope: Delete clause.
4.2.3	General principles for maintaining power system security: Delete clause.
4.3	**Power system security obligations and responsibilities**: Deleted parent heading clause to reflect reduced content.
4.3.1	Time for undertaking action: Delete clause – covered in SCTC.
4.3.2	Network Operator: Retain paragraphs (a) to (d). Modify paragraphs (f) & (g) to refer to consultation with the Power System Controller.
4.3.3	Power System Controller: Delete clause – covered in SCTC.
4.3.4	Users: retained, but heading modified
4.4	**Power system frequency control:** Deleted parent heading clause to reflect reduced content.
4.4.1	Power system frequency control responsibilities: Delete clause – covered in SCTC.
4.4.2	Operational frequency control requirements: Delete clause – covered in SCTC.
4.5	**Voltage control:** Heading modified to reflect reduced content.

NTC Clause	Description of proposed amendment
4.5.1	Network voltage control: new paragraph (e) added to ensure that the limits in paragraph (c) are recorded in the SSG.
4.5.2	Reactive power reserve requirements: Delete clause – covered in SCTC and SSG.
4.6	**Power system operating procedures**: Deleted parent heading clause to reflect reduced content.
4.6.1	Network operations: Delete paragraph (a). Retain paragraphs (b) & (c) in NTC.
4.6.2	Switching of reactive power facilities: Delete paragraph (a). Retain paragraph (b) in NTC with suitable editorial amendments.
4.6.3	Generation limits: Deleted – superfluous as equipment ratings advised to the Power System Controller are not exceeded as a fundamental principle.
4.7	Power system security operations – Heading deleted as no longer reflects reduced content, new heading may be added.
4.7.1	Users' advice: Delete clause – covered in SCTC.
4.7.2	Protection or control system abnormality: Delete clause. Transfer provision to new SCTC clause 6.7.4
4.7.3	Power System Controller advice on power system emergency conditions: Delete clause. Transfer paragraph (a) to new SCTC paragraph 7.5(b) with suitable modifications. Transfer paragraph (b) to System Control Incident Reporting Guideline.
4.7.4	Managing a power system contingency event: Delete clause –covered in SCTC.
4.7.5	Managing electricity supply shortfall events: Delete paragraphs (a)(1), (2) & (3), and (c). Retain paragraphs (a)(3) and (b) with editorial to change 'notice' to 'direction'.
4.7.6	Directions by the Power System Controller affecting power system security: Retain paragraphs (a) & (b) with suitable modifications to focus on un-licenced Users.
4.7.7	Disconnection of Generation Units and/or associated loads: Modified paragraph (a)
4.7.8	Emergency black start-up facilities: Retain provision on NTC.
4.7.9	Black system procedures: Delete clause –covered in SCTC.
4.7.10	Black system start-up: Delete paragraphs (a), (c), (d) & (e). Retain paragraph (b) in NTC.
4.7.11	Review of operating incidents: Delete clause – covered in SCTC.
4.8	**Power system security support:** Heading deleted as no longer reflects reduced content, new heading may be added
4.8.1	Remote control and monitoring devices: Deleted – covered under proposed NTC 3.3.6 and sub clauses.
4.8.2	Operational control and indication communication facilities: Deleted – covered under proposed NTC 3.3.6 and sub clauses.

NTC Clause	Description of proposed amendment
4.8.3	Power system voice/data operational communication facilities: Delete clause –covered in SCTC.
4.8.4	Records of power system operational communication: Delete clause –covered in SCTC.
4.9	**Nomenclature standards:** Replace provision with a single paragraph to cross-reference SCTC. Transfer all paragraphs to the SCTC clause 6.14.
9.1.2	Commitment of Generation Units: Delete clause. Provision no longer relevant to the SCTC or the NTC.
9.1.3	De-commitment, or output reduction, by Users requiring standby power: Delete clause. SCTC suitably modified to accommodate this provision.
9.4	**Generating limits:** Deleted – superfluous as equipment ratings advised to the Power System Controller are not exceeded as a fundamental principle.
10	**Metering requirements:** Deleted - superseded by Chapter 7A of the NT NER from 1 July 2019.
11.3	**Information to be provided by Users with Generators:** Transferred to clause 3.3.4
12	**Transitional arrangements and derogations from the Code:** Heading changed
12.1	Purpose and application: updated paragraph (d) to reflect change in laws. New paragraphs (d) to (g) establish a process for derogations from the Code.
12.2	Pre 1 April 2019 plant and equipment: New provisions to allow for grandfathering.
12.3	Post 1 April 2019 plant and equipment: New provisions for Generator Users who have entered into a connection agreement with the Network Operator prior to Version 4 of this Code coming into effect but has not completed the connection of plant and equipment to the electricity network prior to 1 April 2019. A new Schedule S4 establishes grace periods for specified technical components.
13.2	**Amendments to Planning Criteria:** Paragraph (c) is made subject to paragraph (f). New (d) allows extension of the 30 day period to allow for required consultation.
13.9	**Investment analysis and reporting:** In paragraph (d)(4), changed to refer to spinning reserve 'or C-FCAS as applicable in each regulated power system'.
16.3(b) & (e)	**Frequency stability criteria:** Added RoCoF (rate of change of frequency) regional objectives. New clauses (b) added, (d) changed to refer to spinning reserve 'or C-FCAS as applicable in each regulated power system'.
19.4	**Noise:** Updated reference to relevant statute.
Attachment 1 Glossary	Various terms used have been standardised across the codes, with definitions aligned with the NT NER where appropriate.

NTC Clause	Description of proposed amendment
Attachment 6	Access Application schedule: Deleted, to reflect repeal of third party access legislation and code.
Schedule S4	A new Schedule S4 establishes grace periods for the purposes of clause 12.3

C.2 System Control Technical Code (SCTC) amendments

Table 1 – Amendments to SCTC (draft as at 3/9/19)

Clause	Description of proposed amendment
1.1 opening paragraph	Authorisation: Editorial. Delete term 'Technical', and in all other similar references throughout the Code.
1.3(f)	Application: Editorial. Rework to clarify intent and improve understanding.
1.4(d)	Interpretation: Editorial. Change 'Ring Fencing Code' to italics font. Define in the Glossary.
1.7.4	Obligations of the Power System Controller: Editorial. Modify the presentation of paragraph (a) to align its intent with clause 38 of the *Electricity Reform Act*; new text introduction in (a)(2); updated reference to Acts and Regulations in (b)
3.2.3(b)	Further classification of generating units: Restructured to make the categories (i.e. scheduled, semi-scheduled and non-scheduled) and basis for their classification clearer.
3.3.1(s)	Directions or instructions: Clarifies that the Network Operator is to have contractual arrangements in place to allow directions or instructions from the Power System Controller to be acted on by un-licenced Network Users, and vice-versa, in accordance with the mechanism in clause 3.3.3
3.3.3	Responsibilities of the Network Operator: Clarifies the responsibilities of the Network Operator in maintaining power system security.
3.11	Forecasts: Heading changed to delete word 'load' to clarify requirements for 7 day and 30 day ahead forecasts. Clause 3.11.1(a) amends format for generation capability for active power.
4.3(a)	Dispatch Principles: A new paragraph (7) provides that where possible, in normal operation, scheduling ancillary services from generating systems operated by Generators (other than Territory Generation) that pay for ancillary services under A6.11 should result in an equivalent or increased dispatch level (for the Darwin-Katherine power system).
6.5.1	Types of outages: Clause restructured for clarity, and new 'performance issue outage' added in paragraph (d).
6.6	Forced Outages: Title and opening paragraph changed to reflect changes to clause 6.5.1.

Clause	Description of proposed amendment
6.7.4	Protocols for protection or control system abnormality: NTC revision. New clause added to enable the intent of current NTC clause 4.7.2 'Protection or control system abnormality' to remain unchanged in the SCTC.
6.14	Plant numbering, nomenclature and Drawings: NTC revision. The wording from the definition of 'nomenclature' has been added clause 6.14 as the opening paragraph. The principles, in paragraphs (a) to (j), have been extracted from NTC clause 4.9 'Nomenclature standards'. The NTC clause 4.9 has been removed from the NTC. The definition has been streamlined. A new paragraph (l) has been added for generators granted a relevant derogation under clause 12.1 of the Network Technical Code
6.21.4	Statutory reference in paragraph (d) has been updated
7.3.4	Incident reporting guideline: Changes to make guideline development mandatory, not discretionary.
7.5(b)	Public reporting: New paragraph (b) stipulates content for the Incident Reporting Guideline.
Glossary	Various terms used have been standardised across the codes, with definitions aligned with the NT NER where appropriate

29 August 2019

Our ref: E308248

Jodi Trigg

NTEM Project Director | Core Operations

Power and Water Corporation

Ben Hammond Complex

Darwin NT 0801

Dear Jodi

Review of submissions from Round 2 of the Generator Performance Standards (GPS) Stakeholder Consultations

As requested by Power and Water Corporation (PWC), Entura has reviewed stakeholder submissions made under Round 2 of the Northern Territory (NT) GPS Stakeholder Consultations with a view to determining whether any of the submissions would alter Entura's technical advice as presented in our report "NT Generator Performance Standards Code Review", Doc ID E308248, dated 20 June 2019.

We have reviewed the following submissions received via the PWC website:

- NT Solar Futures
- Tetris Energy
- Assure Energy
- Pro Analytics
- NT Airports
- Territory Generation
- Climate Action Darwin
- Energy Developments Pty Ltd (EDL) – Late submission

Plus three confidential submissions provided by PWC.

On the basis of this review, and a review of the scope of work and technical advice presented in our report, we confirm that our position as presented in that report is unchanged.

We offer the following commentary to expand on this position:

- Scope
  - A number of elements raised in the submissions are outside the scope of Entura's previous technical advice, and so these have no bearing on our position expressed in this letter. These include submissions in respect of:
    - Grandfathering conditions
    - Consultation processes
    - Definitions, drafting errors, cross referencing conflicts, documentation hierarchy
    - General or overarching statements about the renewable energy outcomes and alignment with policy.
- Forecasting accuracy
  - A number of submissions cite limitations in forecasting accuracy as a barrier to the proposed plant output forecasting requirements. Entura understands that these submissions relate to the accuracy of technologies to forecast solar PV output due solely on irradiance variation. Entura's baseline position in its report is that the proposed forecasting requirements can be met through the implementation of energy storage (thus providing sufficient backing for plant output forecasting), and as such are not reliant on irradiance forecasting.
  - Entura also recognised that irradiance forecasting may be available as an alternative to energy storage. In considering this alternative, we noted the need to forecast minimum production, not expected production (requiring a level of curtailment). The intent of Entura's statement was that plant output could be forecast in compliance with the requirements after taking into account the uncertainty in irradiance forecasting and adopting an acceptable risk position (for example, 90% probability of exceedance). Entura is aware that the confidence interval of prediction expands with the length of the forecast window and under partially cloudy conditions and that this may mean a relatively high self-imposed curtailment costs in early years, however, we expect irradiance forecasting accuracy will improve substantially over time and with more operational experience.
  - Some submissions include requests for forecasting requirements that are based on the current capability and accuracy of irradiance forecasting (i.e. shorter duration forecasts or allowing positive / negative variation within bounds of estimated production). Entura does not consider that these approaches would inherently meet the dispatch requirements driving the GPS changes (and again notes that limitations in one technology should not drive the standards, considering that other approaches such as storage are available).
  - For information, Entura has examined commercial supplier forecasting data from current operational sites in the NT. This data shows that current irradiance forecasting systems can forecast 5 minute interval production levels, up to 30 minutes ahead, such that the average actual production for the forecast interval meets the requirements of the forecasting provision (i.e. 90% of forecasts not exceeding actual capacity; remaining forecasts within 5% or 1 MW of actual capacity). As such, Entura's assessment

considered what storage provisions are required within a 5 minute interval prevent short duration (15s) dips in generation below the forecast level, and our findings are based on this assessment.

- For embedded generators coupled with load (including zero export systems)
  - Entura agree that there may theoretically be circumstances embedded generation systems coupled with load may have a zero export constraint and be prevented from meeting proposed forecasting requirements because of load variation. Considering the minimum generator size where the requirement applies, Entura consider it very unlikely that any new generators would connect under a zero export constraint.
- Generator classification
  - A number of submissions argued for the need to have different conditions for different generator types to suit their inherent capabilities. While not directly related to Entura's scope, Entura has considered the implication that some types of equipment need not be subject to forecasting or reactive power requirements. In this respect, Entura's view is that:
    - The forecasting requirements are likely to be sufficiently flexible for different generator requirements. As noted above, for solar PV plant, requirements can be achieved through coupling battery storage (or alternates) and as per our report, reactive power and frequency control requirements can also be met.
    - For other specialised equipment like synchronous condensers or flywheels, forecast energy would generally constant power consumption near zero and reactive power can be provided via the alternator, and thus can be accommodated under the requirements.
    - The forecasting, reactive power and frequency control requirements can be met by a range of generators providing different grid functions even if in some instances the forecasting requirements do not directly add value.
- Distributed generation and spatial smoothing of solar variations
  - A number of submissions argued spatial distribution of medium and small generators may have benefits including:
    - Greater spatial smoothing of total solar generation resulting in reduced forecasting requirements on individual generators and reduced total reserve capacity requirements.
    - Reduced risk of loss of reserve capacity from a fault on the Channel Island – Katherine interconnector (in particular).

    And that consequently this may favour a centralised approach.
  - While the specific benefits of spatially distributed generation are generally consistent with Entura's views expressed in our report, Entura has also recognised that there is currently potential for significant clustering of generation in the network, which may negate spatial smoothing benefits. This clustering would build in a reliability risk with relatively high frequency of occurrence (substantial change in total generation output due to cloud banks multiple times per year).

    - Entura's report also noted the risk of locating ancillary services on radial feeders (e.g. Channel Island – Katherine interconnector) where a fault on that feeder may prevent access to these services.
    - The impact of these factors will depend on network planning and siting of new projects.
- Costs
    - Several submissions challenge the notion that distributed storage with generation is least cost and argue that centralised storage will result in lower cost to customers. Some specifically challenge Entura's 'suggestion' that distributed storage with generation is least cost. Entura's view on this is:
        - Entura did not identify in its report that distributed storage would be the least cost solution (Entura has not conducted an economic analysis of the options), only that it was more likely to deliver a least cost solution considering the factors in its favour. Aside from the following two arguments, the submissions provide limited detail in support of their position, nor do they specifically address the points in favour of distributed storage with generation presented in Entura's report.
        - The first argument against distributed storage being least cost was the scarcity of DC coupled battery solutions in the Australian market. Entura agrees that this is currently the case (noting that there are still some suppliers), but our view is that this is not due to technical limitations but rather to a lack of current demand in the market driving these product offerings from suppliers. DC coupled solutions are more widely available in the international market and while there has typically been a short lag introducing new products in the Australian market, Entura do not consider their availability a major barrier to the proposed requirements. Further, as per our report , there are several other ways to meet the requirements than just DC coupled battery solutions.
        - The second argument was that centralised batteries can offer a range of other services such as fast frequency response (R-FCAS, C-FACS), reactive power provision, synthetic inertia, real and reactive fault contribution, voltage support, etc. However, in Entura's view, all of these services can also be provided by distributed storage, and in some instances such as voltage support and active power smoothing, distributed capacity may be more valuable than centralised capacity in improving network infrastructure utilisation (and delaying new investment).

Yours sincerely

Chris Blanksby
Specialist Renewable Energy Engineer
t 0408 536 625
e chris.blanksby@entura.com.au

APPENDIX F. INDUSTRY-INITIATED CODE CHANGE PROCESS

Subject to Utilities Commission agreement, Power and Water proposes to provide the following information on the Market Operator website.

Industry Initiated Code Change Proposals

Under the Network Technical Code (NTC) and the System Control Technical Code (SCTC) entities holding electricity related licences in the NT are eligible to propose code change requests to the NTC and SCTC.

Where such a code request has been made, Power and Water will respond within 30 days with a determination to:

- approve that the amendment is suitable for consultation, and initiate a code consultation process for the rule change; or
- hold the amendment until there is a sufficient volume for a code amendment; or
- reject the proposed amendment.

All code change proposals received from system participants will be published online within the 30 days, along with the Power and Water determination.

A code change proposal is initiated submitting to the market.operator@powerwater.com.au *inbox with the following information:*

A code change proposal is initiated by:

- Draft code amendments (specific wording);
- Explanation of the reason for the code amendment (issue);
- Explanation of how the proposed amendment will solve the issue identified;
- Explanation of the impact of the amendment on other system participants; and
- Explanation of how the change aligns with the criteria for approving the change in the *Utilities Commission Act*.

Submissions meeting the required information (as determined by the General Manager Operations or their delegate) shall then be reviewed by the Power and Water NTEM Steering Committee for determination as to the action to be taken.

If the General Manager Operations (SCTC) or the General Manager Power Services (NTC) do not consider that the proposal should proceed to the NTEM Steering Committee (due to insufficient information being provided) they may return the code change to the proposer, with a summary of the nature of the missing information or other reason why the proposal was not considered suitable for consideration by the NTEM Steering Committee.