PowerWater

POWER NETWORKS
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NETWORK PLANNING CRITERIA

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1 INTRODUCTION

Transmission and distribution networks owned by Power and Water cover the major centres of the Northern Territory. The legislated Third Party Access regime gives rights to private generators and load customers to use the networks to enable contracted trade between generator users and customer users.

Additions to the networks in the form of extra:

- transmission lines and distribution feeders
- transformers
- generators
- loads
- capacitors or reactors

will produce an impact on the existing networks.

Power and Water is the major custodian and operator of the power networks 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 changes to the networks or user's installations are made. Technical requirements are based on the rules, criteria and limits included in the Technical Code and these Network Planning Criteria.

This document presents the planning criteria applied to ensure that Power and Water's networks:

- provide a high quality electricity supply
- provide a reliable electricity supply
- provide a secure electricity supply
- meet safety standards
- meet environmental standards
- optimise equipment utilisation
- optimise network losses

The philosophy of network planning and the rationale behind the planning criteria are discussed in Section 2 of this document.

The guidelines for network planning, which are given in Section 3 of this document, outline the range of technical and environmental planning criteria.

The purpose of planning criteria is to help strike a balance between the 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.

2 DESIGN PHILOSOPHY

The planning criteria are used to assess network capacity and determine the need for and timing of network reinforcement or re-configuration. Network reinforcement plans are then developed which will satisfy the planning criteria and environmental constraints.

2.1 NETWORK DESIGN PHILOSOPHY

2.1.1 Transmission and Sub-transmission Networks

Power and Water designs its transmission and sub-transmission systems as meshed networks, though invariably there will be radial transmission and / or sub-transmission lines in many rural and developing areas.

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 customers. This is the ‘n-1’ criterion, which can result in imprudent capital expenditure. 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 customers. If the probability is low and the consequences minimal, it may be considered justified to delay system reinforcement beyond the date indicated by the n-1 criterion.

2.1.2 Distribution Networks

Power and Water designs its distribution networks as radial systems and in normal circumstances the loss of a component of the network will result in the loss of supply to a number of users. The extent of the loss of supply is minimised by the use of reclosers and sectionalisers and the speed of fault location is improved through the use of fault indicators.

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. The switching stations are remotely controlled, but the intermediate switches are operated manually.

In urban areas the density of users often results in an open, meshed network that is run radially with open points. This operating mode minimises fault levels and simplifies technical and operational requirements. In these situations improved supply restoration times are possible, although the initial loss of supply will still occur.

In rural areas the distribution network is, generally, radial and interconnection to reduce supply restoration times is often not possible.

Users requiring additional security of supply above the standard design philosophy will be accommodated where possible, although, in some circumstances, on-site standby generation may be the only practical alternative. Additional costs incurred in providing the additional security of supply may be charged to the user.

The distribution network is not designed for islanded operation of generators and Power and Water’s distribution equipment is not normally fitted with synchronising equipment. Embedded generating units shall be disconnected from the network if the distribution feeder that they are connected to is separated from the remainder of the power system.

2.2 The Process to Assess Network Capacity and the Need for Network Reinforcement

Network capacity and the need for network reinforcement are assessed by comparing the planning criteria with network performance for:

- increasing load levels
- changing load demand patterns
- particular load characteristics
- reliability

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:

- the load forecast
- the anticipated maximum demands of all users
- special conditions of the user's load
- the anticipated minimum demand of other users
- user load profiles
- age and condition of existing assets.

Economic analysis is used in assessing network reinforcement requirements and serves four functions:

- it indicates the return to Power and Water of proposed capital investment
- it helps to choose between options
- it helps rank the project with other projects generated throughout Power and Water
- it ensures the equitable allocation of costs between users.

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.

2.3 The Process of Developing Network Concept Plans

Power and Water, in developing network concept plans for the long-term development of the network, uses ultimate load horizon planning.

In this methodology Power and Water considers the following information in assessing the ultimate load for an area:

- Department of Lands Planning and Environment land use structure plans
- Australian Bureau of Statistics censuses
- Consultants' reports on population growth in the major centres
- Any relevant town planning schemes
- Local Government advice on future planning proposals
- Geographic features and their associated design limitations
- Any environmental constraints, including vegetation and ecology limitations

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.

3 PLANNING CRITERIA

Planning Criteria are a set of standards applied to maintain 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 networks against instability.

3.1 CONTINGENCY CRITERIA

Contingency criteria relate to the ability of the network to be reconfigured after a fault so that the unfaulted portions of the network are restored.

3.1.1 Network Reliability

Power and Water will plan and design its networks so that the System Average Outage Duration time (SAOD) is minimised.

3.1.2 Urban High Voltage Distribution Feeders

High voltage distribution feeders in urban areas shall be planned and designed so that, for a zone substation feeder circuit or exit cable fault, the load of that feeder can be transferred to adjacent feeders by manual network reconfiguration.

Where practical, the network shall be planned and designed so that, in the event of a failure of a zone substation transformer, all of the load of that transformer can be transferred to other transformers within the same zone substation and adjacent zone substations.

3.1.3 Rural High Voltage Distribution Feeders

The radial nature of rural distribution feeders normally precludes the application of contingency criteria to these feeders. However, where reasonably achievable, interconnection between feeders shall be provided, and reclosers and sectionalisers shall be installed to minimise the extent of outages.

3.1.4 Low Voltage Distribution Networks

Where practical, low voltage distribution networks in urban areas are constructed as open rings to provide an alternative supply to as many customers as possible.

3.2 STEADY STATE CRITERIA

The steady state criteria define the adequacy of the network to supply the energy requirements of users within the component ratings and frequency and voltage limits, taking account of planned and unplanned outages.

The steady state criteria apply to the normal continuous behaviour of a network and also cover post disturbance behaviour once the network has settled.

In planning a network it is necessary to assess the reactive power requirements under light and heavy load to ensure that the reactive demand placed on the generators, be it to absorb or generate reactive power, does not exceed the capability of the generators.

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 loads shall be disconnected until the frequency rises to an acceptable level.

In the following sub-sections, the various components of the steady state planning criteria are defined.

3.2.1 Real and Reactive Generating Limits

Limits to the VAr generation and absorption capability of generators shall not be exceeded.

Generators shall be capable of supplying the VArs for the associated load and also those necessary to maintain the voltage at the connection point at the level that existed prior to the connection of the generator.

3.2.2 Steady State Voltage Limits

3.2.2.1 High Voltage

The network shall be designed to achieve 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.

3.2.2.2 Low Voltage

The network shall be designed to achieve a low voltage steady state voltage within:

± 6% of the nominal voltage during normal conditions
± 8% of the nominal voltage during planned maintenance conditions
± 10% of the nominal voltage during unplanned outage conditions

3.2.3 Frequency Limits

Under emergency conditions the network frequency may vary between 47 - 52 Hz, until the under frequency load shedding schemes operate to reduce the load on the network.

The normal operating frequency ranges for the networks are:

Darwin – Katherine System
Under normal conditions the network frequency shall be maintained at 50 Hz ± 0.2 Hz.

Alice Springs System
Under normal conditions the network frequency shall be maintained at 50 Hz ± 0.4 Hz.

Isolated, Regional Distribution Networks
Under normal conditions the network frequency shall be maintained at 50 Hz ± 1.0 Hz.

3.2.4 Thermal Rating Limits

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

1. Transformers: Normal manufacturer's name plate rating.

2. Switchgear: Normal manufacturer's name plate rating.

3. Overhead Lines: Rating calculated in accordance with ESAA Code D(b)5, and based on:
    - ambient temperature of 35°C in the northern part of the Territory, and 40°C (summer) or 25°C (winter) in the southern part;
    - wind speed being 0.5 m/s;

- solar radiation being 1000W/m^2 (weathered surface); and
- conductor design clearance temperature as defined in ESAA Code C(b)l.

4. Cables: Normal cyclic rating, calculated using the Neher McGrath methodology, with maximum operating temperatures of 90°C for XLPE cables; 70°C for 11 kV paper insulated cable and 65°C for 11 kV paper insulated, belted cable and 22 kV paper insulated cables.

   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.

3.2.5 Fault Rating Limits
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.

The maximum fault levels on Power and Water's networks are currently:

- 11 kV networks18.4 kA
- 22 kV networks13.1 kA
- 33 kV networks13.1 kA

Equipment owned by Power and Water and connected to the network is designed to withstand these fault levels for 1 second.

3.3 STABILITY CRITERIA

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 loading conditions and generation schedules, under normal operating conditions, following the loss of any item of plant, and for the most severe faults. In the planning and operation of a power system it is important to consider the potential emergence of a variety of stability problems.

The planning criteria are designed to ensure that the network has a high probability of remaining stable following all credible network disturbances.

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.

Two broad categories of stability are considered:

- Angle stability, which mainly involves the dynamics of generators and their associated control systems. Angle stability can be further categorised into transient stability and small-signal or steady-state stability. Frequency stability is closely related to angle stability.

- Voltage stability, which mainly involves the dynamic characteristics of loads and reactive power compensation. Voltage collapse is perhaps the most widely recognised form of voltage instability.

3.3.1 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, 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 which is cleared by the faster of the two protection schemes with all intertrips assumed in service.

If the rotor angles between one (or a group) of synchronous machines and the rest of the generating units on the network reaches and/or exceeds 180°, a "pole slip" occurs. This results in loss of synchronism or synchronous instability.

3.3.1.1 Rotor Angle Swing

In general, an initial generator rotor angle swing which does not exceed 120° and with $X_T \leq$ 1.0 p.u. is considered stable.

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.

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 groups containing various generators a correlated effect on the network, like transient voltage dip limits, shall be used to prevent synchronous instability.

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:

- network voltage collapse
- motor load loss on undervoltage

Such impacts on a network are not acceptable and enforceable limits need to be used to prevent them.

3.3.1.2 Fault Clearance Time

One of the major factors affecting transient stability is the fault clearance time. The critical fault clearance time is the longest time that a fault can be allowed to remain on the network whilst maintaining network stability. Protection shall be installed to ensure that the critical fault clearance times are achieved.

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.

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 pattern.

Any plant leading to network instability shall be separated from the healthy network.

3.3.1.3 Rotor Angle Swing and Transient Voltage Dip

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.

Any generator connected to the distribution network shall not cause the Transmission voltage to exceed the transient voltage dip criteria defined in the Network Technical Code.

3.3.1.4 Pole Slip Protection

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.

Pole slip protection is to be installed on all generating units where simulations show that pole slipping is likely following any credible plant outage or fault.

3.3.2 Small-signal Stability

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.

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 can fall out of synchronism with each other and pole slipping can occur.

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.)."

Statistical effects shall be taken into account when analysing test results.

3.3.3 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.

3.3.4 Power System Stabilisers

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 stabilisers. These are to be installed on those generating units where they will be most effective in improving overall system damping.

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.

3.3.5 Voltage Stability

Voltage stability is a function of the dynamic characteristics of system loads. A power system at a given operating state and subject to a given disturbance is voltage stable if post-disturbance voltages 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.

Voltage instability most commonly results in voltage collapse, but may give rise to excessively high voltage levels under some conditions.

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 reactors, SVCs, synchronous condensers, etc.

3.3.5.1 Voltage Collapse

A power system undergoes voltage collapse if post-disturbance voltages are below acceptable limits. Voltage collapse may be total (blackout) or partial.

The possibility of an actual voltage collapse depends upon the nature of the load. If the load is stiff (constant power) 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.

3.3.5.2 Resonance Conditions

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.

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).

If resonance is excited following a network disturbance, then oscillations appearing as network voltage amplitude modulations can arise.

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.

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.

Locations with a low fault level and a weak electrical connection (usually with impedance higher than 1.0 pu to the source) are prone to sub-synchronous oscillations or resonance.

3.3.5.3 Transient Over-Voltages

Transient over-voltages 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.

3.3.5.4 Temporary Over-Voltages

Temporary AC over-voltages 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 loads have been adequately mitigated.

3.3.6 Frequency Stability Criteria

The frequency stability criterion relates to the recovery times for excursions of the system frequency from the steady state limits.

To cover for a loss of generating plant there are two measures applied to bring back the falling frequency:

- spinning reserve
- under-frequency load shedding (UFLS)

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 or its interconnection.

Following loss of generating plant, system frequency, depending on spinning reserve, 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.

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

a) under the automatic control of under frequency relays; and
b) under manual or automatic control from control centres; and/or
c) under the automatic control of undervoltage relays.

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

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

The settings for under-frequency load shedding in the various regions throughout the Northern Territory are given in Table 2.8 of the Network Connection Technical Code.

3.4 QUALITY OF SUPPLY

Quality of supply criteria regulate the voltage and current waveforms in the network and criteria are established for the following aspects:

- Voltage fluctuation
- System Frequency
- Harmonic distortion
- Voltage unbalance
- Network reliability

The transmission and distribution networks are analysed to ensure satisfactory performance, in accordance with the quality of supply criteria, whenever a new user is connected or a complaint from an existing user is received.

The aspects of quality of supply that are analysed are:

- Steady state voltage
- voltage fluctuation
- network frequency, on isolated regional networks.

Harmonic voltage and current and voltage unbalance will be analysed depending on the nature of the load of the new user being connected.

3.4.1 Voltage Fluctuation Limits

A user shall ensure that variations in current at each high voltage connection point do not cause voltage fluctuations to exceed the limits set out below:

High Voltage

Voltage fluctuations shall not exceed the threshold of perceptibility curve shown in Figure 1 of AS 2279.4 - 1991, with the voltage fluctuation reduced by 50%.

Low Voltage

Voltage fluctuations shall not exceed the threshold of irritability curve shown in Figure. 1 of AS 2279.4 - 1991, with the voltage fluctuation reduced by 70%.

The limit to voltage fluctuation contribution is subject to verification of compliance by Power and Water.

Responsibility of Power and Water for excursions in voltage fluctuations outside the threshold of perceptibility curve for high voltage and outside the threshold of irritability for low voltage shall be limited to the pursuit of all measures available under the Regulations and this Code to remedy the situation in respect of users whose plant does not perform to the standards specified in this clause.

3.4.2 System Frequency

The frequency shall comply with the requirements of clause 3.2.3.

3.4.3 Harmonic Distortion

3.4.3.1 Harmonic Voltage and Current Distortion

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 AS2279 Part2 – 1991. Refer also to Section 2.4.2 of the Network Connection Technical Code.

3.4.3.2 Direct Current

All 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 120 mAh per day.

Responsibility of Power and Water 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 and the pursuit of all measures available under the Regulations and this Code to remedy the situation in respect of users whose plant does not perform to the standards specified in this clause.

3.4.4 Electro-magnetic Interference

Power and Water shall design its networks to ensure that the electro-magnetic interference caused by its plant and equipment does not exceed the limits set out in Tables 1 and 2 of Australian Standard AS2344.

3.4.5 Voltage Unbalance

A user shall not cause the voltage unbalance factor at each of its connection points to increase from the level that existed prior to the connection of the user by more than 30% of the limits specified in Table 2.5.

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

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

Table 2.5 Voltage Unbalance Factor Limits (%)

Notes to Table 2.5:

1) The 5-minute time period restriction means that an increase in the voltage unbalance factor of up to 0.45% (30% of 1.5) is permissible for an aggregate of up to 5 minutes in any 30-minute period.
2) The instantaneous value refers to the largest VUF recorded.
3) The 30% proportion is based on an allowance for existing voltage unbalance and future voltage unbalance sources.

For voltage levels less than 66 kV, the following is the voltage unbalance factor definition:

VUF = (MaxAV + AvgV) * 100%

Where:

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

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

3.5 CONDUCTOR SELECTION CRITERIA

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 constraints and where the additional cost can be justified.

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.

In designing extensions 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 life time cost to the community.

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 users the least cost network.

- 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.

- 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.

3.6 CONSTRUCTION STANDARDS CRITERIA

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" and install the underground portions of its networks in accordance with the Electricity Supply Association of Australia publication C(b)2 - "Guide to the Installation of Cables Underground".

3.7 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 changes to existing processes provide for consideration of best environmental practice technology and timely impact assessment,
- To carry out its business in a resource efficient manner.

Power and Water's power networks will be developed so that these commitments are met.

3.7.1 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.

3.7.2 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 industry standards.

3.7.3 Land-Use Considerations

Power and Water shall avoid, or minimise damage to natural, cultural and historical sites consistent with the safe and reliable operation of the electricity supply network.

3.7.4 Noise

Power and Water shall meet and, where possible, better the noise limit provisions of the Environmental Protection Act.

3.7.5 Visual Amenity

Given that the community and customers 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.

3.8 FINANCIAL CRITERIA

Expenditure on network extension or reinforcement is supported by rigorous financial analysis. Where appropriate, several alternative options are analysed, and the option with the most favourable NPV is selected.