TransGrid

NETWORK MANAGEMENT PLAN

D Croft

Chief Executive

Network Management Plan

Table of Contents

1. Introduction

This Network Management Plan has been prepared in accordance with the Electricity Supply (Safety and Network Management) Regulation 2002. The object of the Plan is to ensure that TransGrid's transmission system provides accessible, efficient, safe and reliable facilities for the transmission of electricity, in an environmentally and socially responsible manner.

The electricity industry in Australia has undergone significant change with the separation of generation, transmission and distribution and the establishment of a national electricity market operator. These changes have been accompanied by the introduction of a national electricity code for market participants and the involvement of the Australian Consumer and Competition Commission in the setting of income and service standards for transmission network service providers such as TransGrid.

At State level there has been an increasing focus by shareholders and customers in the performance of transmission and distribution companies and in particular on reliability and availability of supply. This has been reinforced through the New South Wales Electricity Supply (Safety and Network Management) Regulation 2002 that requires Network Operators to develop Network Management Plans and to report annually on the performance of the network.

Against this backdrop TransGrid has developed this Plan, utilising existing and current corporate documents and plans. The Plan provides a focus for ongoing analysis within TransGrid and at continually improving the management of the transmission system. It also provides a formal method for information dissemination to customers, shareholders and regulators.

TransGrid's corporate objectives are achieved primarily through the strategies in this Plan. The Plan describes the model TransGrid uses to manage and develop its assets and the asset management strategies for network enhancement, maintenance and disposal. These strategies are integrated with non-asset strategies such as human resources, finance, information technology and procurement.

In many cases and in particular where network additions or augmentation are involved the need for such work is driven directly by customer needs and requirements. This Plan has been developed in parallel with an annual planning review conducted by TransGrid as the Jurisdictional Planning Body for New South Wales and therefore it will by necessity be a living document that will change in response to feedback from customers and market participants.

2. Structure of Plan

The requirements of the Electricity Supply (Safety and Network Management) Regulation 2002 (the Regulation) were, prior to this regulation, being met by TransGrid, with minor exceptions, via one major document, the "Network Management Plan 2001 – 2006." That document will be attached to this cover document, and the whole shall constitute the Plan.

Section 4 of this document lists the scheduled requirements from the Regulation and indicates against each the location of the applicable information.

Section 5 of this document provides the additional information that supplements that provided in the referred document to meet the full requirements of the Regulation.

3. Referred Documents

3.1 Network Management Plan 2001-2006 (Referred to hereafter as NMP 01/06)

This NMP 01/06 specifically describes and details the planning and service delivery strategies and standards and the resulting capital investment strategy.

It also details the asset management strategies including the various policies, strategies and standards. It lists the programs for each of the asset categories detailing specific issues and the strategy for dealing with the issues. It also details the different measures used to determine the performance of the assets including technical performance assessments, quarterly asset performance reviews and benchmarking studies.

Asset disposal and waste strategies are also included in this document.

NMP 01/06 covers all assets comprising or relating to the network including:

- Transmission Lines and Cables including easements and access tracks
- Substations and Switching Stations including all associated plant

- Protection, Metering and Communications equipment and associated facilities.

It does not cover non-network assets such as motor vehicles, furniture, non-system related land, buildings and equipment (eg. corporate computers and business systems).

NMP 01/06 was prepared on the basis that it is an overview document that leads to the preparation of more detailed working documents identified in the Network Management Process. These include the Annual Planning Statement, the Asset Management Strategies, the Maintenance Policies and the CAPEX and MOPEX Resource Plan.

NMP 01/06 includes a Network Management Model which provides a framework for the strategic planning and management of TransGrid's physical asset resources and is based on the New South Wales Government's Total Asset Management (TAM) Model. The model shows the direct linkages between TransGrid's Corporate Plan and its Service Delivery Strategies to the Network Management Plan.

NMP 01/06 also includes details and references to management support systems such as the Quality System, the Health and Safety Management System, the Environmental Management System and the Emergency Management System.

4. Guideline to Location of Elements of Network Management Plan

Various elements of the Electricity Supply (Safety and Network Management) Regulation 2002 are captured within this covering document and the "Network Management Plan 2001-2006" referred to here as NMP 01/06.

Regulation Reference	Description	Location in Plan
6 (2) (a)	A commitment by the network operator to ensuring the safe operation of its transmission system, and to giving safety the highest priority over all other aspects of network management	Part 2.2 of NMP 01/06
6 (2) (b)	A description of the transmission system and its design, construction, operation and maintenance	NMP 01/06 pp7 & 8 and Part 4.2. Part 5.1-5.6 of this document
6 (2) (c)	A description of the planning process employed for the purpose of assessing the adequacy of the transmission system and the need for development of the transmission system, including if appropriate:	Parts 3.1 & 3.2 of NMP 01/06
	(i) demand management methodologies	Initiative and measure in Corporate Plan 2003/04, and Part 5.9 of this document
	(ii) system reliability planning standards on a customer class or group, or geographical basis, for each distinct voltage level	Part 3.2.8 of NMP 01/06 and Part 5.10 of this document
6 (2) (d)	A description of the asset management strategies employed for the purposes of the design, construction, operation and maintenance of the transmission system, including:	Part 4.2 of NMP 01/06; Part 5.2 of this document

Regulation Reference	Description	Location in Plan
	(i) risk management and public liability insurance arrangements	Part 4.2.1 (6) of NMP 01/06 Part 5.12 of this document
	(ii) planned customer technical service standards for quality and reliability of supply	Part 3.3 of NMP 01/06
6 (2) (e)	A description of the safety management strategy employed for the purpose of ensuring the safe operation of the transmission system, including:	Part 2.2 of NMP 01/06
	(i) an analysis of hazardous events	Part 2.2.8 of NMP 01/06
	(ii) the procedures to be implemented in the event of an emergency	Part 2.2.9 of NMP 01/06 and Part 5.7 of this document
	(iii) the procedures and standards designed to ensure that the network operator's employees, contractors to the network operator and their employees and any other persons working on or near the system's electricity works have the competencies required to undertake the work safely	Part 5.11 of this document
	(iv) a strategy to ensure adherence to safe working procedures	Part 2.2.7 of NMP 01/06
6 (2) (f)	A description of the plan's objectives and of appropriate performance indicators	Part 1 of this document & Part 3.3 of NMP 01/06
6 (2) (g)	A schedule of reports to be made to the Director-General in relation to the management and performance of the transmission system	Part 6 of this document
6 (2) (h)	A description of the codes, standards and guidelines that the network operator intends to follow in the design, installation, operation and maintenance of the transmission system	Part 5.2-5.4 of this document
Schedule 1	**(Network Management Plans)**	
1.	Description of transmission system: A description of the transmission system and its planning, design, construction, operation and maintenance must include the following:	
	(a) References to maps showing the location of the system's electricity works and the procedures for gaining access to those maps	Part 5.1 of this document
	(b) Design and construction standards and procedures for the system's electricity works	Part 5.2 of this document
	(c) System reliability planning standards	Parts 3.1 & 3.2 of NMP 01/06

Regulation Reference	Description	Location in Plan
	(d) Technical customer service standards for quality and reliability of supply	Part 3.3 of NMP 01/06
	(e) Maintenance standards and procedures for the system's electricity works	Part 5.3 of this document
	(f) Operation and work procedures for the system (including procedures for work on or near both de-energised and live electricity works)	Part 5.4 of this document
	(g) Safety equipment design, use and maintenance standards and procedures for the system	Part 5.5 of this document
	(h) A description of the engineering records, drawings and maps that the network operator maintains on the system	Parts 5.1 and 5.6 of this document
2.	Description of planning process: A description of the planning process employed for the purpose of assessing the adequacy of the transmission system and the need for development of the transmission system must include the following:	
	(a) the process used for setting system reliability planning standards and identifying development needs and demand management opportunities	Part 3.1 & 3.2 of NMP 01/06, TransGrid's Corporate Plan 2003/04 and Part 5.9 of this document
	(b) strategies for managing and complying with that process and those standards	Part 4.1 of NMP 01/06
3.	Description of asset management strategies: A description of the asset management strategies employed for the purposes of the design, construction, operation and maintenance of the transmission system must include the following:	
	(a) the process used for setting design, construction, operation and maintenance standards and customer technical service standards for quality and reliability of supply b) strategies for managing and complying with that process and those standards.	Parts 3.3 and 4.2 of NMP 01/06. Part 5.3 of this document Part 4.2 of NMP 01/06
4.	Analysis of hazardous events: (1) An analysis of hazardous events must, consistent with the size and complexity of the transmission system	

Regulation Reference	Description	Location in Plan
	(a) systematically identify hazardous events that might be expected to occur, and	Part 2.2.8 of NMP 01/06
	(b) identify the potential causes of those events, and	As above
	(c) state the possible consequences of those events, and	As above
	(d) specify operational, maintenance and organisational safeguards intended to prevent those events from occurring or, should they occur, intended to protect operating personnel, plant, equipment, the community and the environment	As above and Part 5.8 of this document
	(2) The operational and maintenance safeguards must include a maintenance schedule indicating, among other things, the type and frequency of inspections and tests of the transmission system (including checks on protection devices)	Part 4.3.2 of NMP 01/06
	(3) In the case of new transmission systems, an analysis of hazardous events should also take into account hazardous events occurring during construction	Part 2.2.8 of NMP 01/06
5.	Emergencies:	
	(1) The types of emergencies in respect of which procedures are to be implemented include:	Part 2.2.9 of NMP 01/06 and Part 5.7 of this document
	(a) fires, explosions and impacts (with particular reference to those caused by the activities of other parties), and	
	(b) natural disasters, and	
	(c) civil disturbances	
	(2) A plan must demonstrate that the network operator regularly tests and, as far as practicable, has proved the emergency procedures	

5. Supplementary Information

5.1 Reference Maps for the Network

TransGrid has produced an Electricity Supply Network map showing locations of TransGrid Network assets. This map is available for viewing on TransGrid's website **www.transgrid.com.au**. The specific locations of individual sites are detailed on registered drawings titled 'Site Location Plan' for that site. Access to these drawings may be requested from the appropriate Regional offices.

5.2 Design and Construction Standards

TransGrid's network assets are designed in accordance with TransGrid's Engineering Design Instructions, Series number 1/A/1 to 6/C/1. These Design Instructions are based on relevant Australian and International Standards and incorporate additional TransGrid requirements developed from experience in operating the System. Equipment used in the electrical works has design specifications fulfilling the criteria for the health and safety of personnel. Construction is carried out to the designs. Post construction review meetings are held to provide feedback on the design and construction process.

All design and construction of equipment for use in TransGrid includes, as part of the specification, the requirements of TransGrid's Safety Rules - GD SA G2 012 and requirements as nominated in Grid Standards and Grid Asset Management Standards.

As applicable, relevant Australian Standards and Codes of Practices are used in designing, selecting and maintaining equipment. Particular codes taken into account and implemented are:

ESAA NENS 01 – 2001 National Electricity Network Safety Code, except that

(a) In lieu of Clause 5.3.1 applying to clearances of overhead services and other cable systems as defined in HB C(b)1, Clause 5.3.5.2 of the *Electricity Association of NSW Code of Practice for Electricity Transmission and Distribution Asset Management, November 1997*, is applied to ensure the maintenance of existing high clearances in NSW.

(b) In relation to Clause 7.3.3, the new *ESAA NENS 04 – 2003 National Guidelines for Safe Approach Distances to Electrical Apparatus* are applied as guidelines for the purposes of this clause.

The *Electricity Association of NSW Codes of Practice – Contestable Works, March 1998; Service and Installation Rules, December 1997; and Service Standards, February 1998* have been taken into account but not implemented in the Network Management Plan as they are not applicable to TransGrid's activities.

Design and construction standards are located on TransNet, TransGrid's intranet site, or in controlled local folders in the Design office.

5.3 Maintenance Standards

TransGrid's assets are managed as directed in the Network Asset Management Procedure – GD AS G2 003. All maintenance work is carried out in accordance with the relevant Asset Management Standard or Grid Standards.

- Substation Maintenance Policy - GM AS S1 001
- Policy on Routine Maintenance on Protection Equipment - GM AS P1 001
- Metering Maintenance Policy - GM AS M1 001
- Communication Maintenance Policy - GM AS C1 001
- Inspection and Maintenance of Transmission Lines - GM AS L1 001

Maintenance standards are located on TransNet, TransGrid's intranet site, or in controlled local folders in the relevant central or regional office.

5.4 Operation and Work Procedures

TransGrid's work procedures are based on a formal process of task analysis and risk assessment supported by the accumulated experience of the organisation and best practice work methods. All work carried out within TransGrid, whether by TransGrid employees or contractors, is carried out in accordance with these procedures. Our procedures comply with the relevant legislation, Codes of Practice and Guides from the ESAA NENS National Electricity Network Safety Code, WorkCover Authority and Worksafe Australia.

Operation and work procedures are contained in TransGrid Safety Rules - GD SA G2 012 which detail the rules for safe work on the transmission system and System Control Operating Manuals which provide operation parameters for specific sites and operating practices and requirements to facilitate safe switching operations.

Work Procedures are contained in Grid and Asset Management Standards:

- GM AS S2 - S3 Series (Substation Procedures and Instructions)
- GM AS L2 - L3 Series (Lines Procedures and Instructions)
- GM LL L2 - L3 Series (Live Line Procedures and Instructions)
- GM AS P2 - P3 Series (Protection Procedures and Instructions)
- GM AS M2 - M3 Series – (Metering Procedures and Instructions)
- GM AS C2 - C3 Series (Communications Procedures and Instructions)
- GM SA G2 - G3 Series (Safety Procedures and Instructions)
- GD EN G2 Series and GM EN G2 Series (Environmental Procedures)

Operation Procedures are contained in System Operating Manuals:

- Cable fault alarms - OM 674
- Customer Switching - OM 907
- Emergency Ratings - Main Grid Circuit - OM 302
- Operating Procedures - OM 670
- Removal of Foreign Objects - OM 696
- Reports - HV forced and Emergency Outage Reports - OM 552
- Restoration of Transmission Circuits - OM 686
- System Separation - OM 670, OM 664
- Use of HV Switching Instructions - OM 978

These standards are located on TransNet, TransGrid's intranet site, or in controlled local folders in the relevant central or regional office.

5.5 Safety Equipment Design, Use and Maintenance

Safety equipment design, care, use, maintenance and frequency of maintenance, used by TransGrid employees and contractors, are detailed in TransGrid's High Voltage Safety Equipment and Procedures which are located in TransGrid's Grid Standards (GD Series Documents):

- GD SA G2 002 - High Voltage Operating Rods
- GD SA G2 013 - Safeguards for Work on High Voltage Transmission Lines
- GD SA G2 014 - Proving High Voltage Equipment De-energised
- GD SA G2 015 - Portable earthing of High Voltage electrical equipment
- GD SA G2 016 - Safeguards for Work on High Voltage Insulated Cables
- Live Line Methods Manual - GM LL Series Documents

These standards are located on TransNet, TransGrid's intranet site, or in controlled local folders in the relevant central or regional office.

A range of Personal Protective Equipment (PPE) is used in TransGrid. PPE is selected with reference to relevant Australian Standards and Codes of Practice and by consultation with employees in the field. Guidelines to employees and managers for appropriate PPE are given in TransGrid's standard GD HS G2 050 "Guide to Safe Working Practices, Equipment and Tools" which is accessible to all staff on TransGrid's intranet, *TransNet*.

5.6 Description of Engineering Records and Drawings

TransGrid maintains the following engineering records and drawings for the transmission system:

Drawings

All electrical layouts and diagrams for all sites and equipment are maintained in the Drawing Management System.

Maintenance Records

All records of completed maintenance work are maintained electronically on the main frame Work Management System (WMS). Hard copies of maintenance test records are filed locally in the Record Management System (RMS) at the appropriate Area Centre.

Operating Records

Outage Requests:
Requests for future outages are located in the main frame Transmission Outage Diary (TOD) system.

Completed Outages:

Records of all relevant details of all outages (scheduled and unscheduled) are contained in the PC Transmission Outage System (TOS).

5.7 Emergencies

5.7.1 Operating Staff

TransGrid's major Network Control Centres are staffed on a 24 hour basis. Operating staff at these centers are trained to operate the system in a safe manner in response to emergency conditions of all types, including:

(a) Fire, explosion, impact (both those caused by TransGrid and by activities of other parties)

(b) Natural disaster

(c) Civil disturbances

In response to natural disasters and disturbances, the operator is required to contact the appropriate emergency service organisation e.g. Fire Brigade etc. Resources available to Operating staff to address these emergencies are:

(i) Operating manuals

(ii) Fire Protection Policies and Procedures Manual GD SA G2 001

(iii) Environmental Manual GD EN G2 002 and associated Emergency Response Manuals

(iv) An Emergency Register containing contact names and phone numbers of all relevant emergency services, including Police, Fire, Ambulance, State Emergency Services, other utilities (Electricity, Water, Gas) is kept in the Data Acquisition and Control system.

System Operating Manuals address:

Bushfires, floods, storms etc. - OM 686, OM 244

Communications breakdown with the System Control Centre - OM 667

Restart of System - OM 666, Area OM X066

System Control Centre - Emergency Procedures - OM 851

5.7.2 General Emergency Plans

TransGrid has a Corporate Emergency Management Plan and Regional Emergency Management Plans which coordinate the Management measures necessary to ensure that TransGrid is prepared for emergencies which may impact on reliability of supply, the safety of staff and the public or environment.

Whilst TransGrid’s assets are exposed to the elements and are therefore impacted by natural events such as bush fires, cyclones and earthquakes, the Plan also applies to failures of major system components and abnormal events such as vandalism and sabotage.

Each Region has for each of its Area Centres a Local Evacuation Plan for incidents such as fire, bomb threat etc. These plans are located prominently on notice boards throughout the Area Centre’s offices and buildings.

Each substation site has an individually designed Emergency Response Manual to deal with environmental emergencies/incidents at that site. These manuals are maintained by the associated Regions and are subject to regular independent audits.

5.7.3 Testing of the Emergency Procedures

The Corporate and Regional Emergency Management Plans are tested on a regular basis by the simulation of emergency incidents. The testing involves the participation of other parties such as NEMMCO, Distributors, other TNSPs and Jurisdictional bodies. This has been successfully tested in past years, the most recent being in March 2002.

Each Region’s Local Evacuation Plan is tested by regular evacuation drills.

Due to the nature of the emergencies that could occur at a substation site, no specific exercises are conducted other than to audit the Emergency Response systems and train the staff. However, when employed during previous genuine conditions, the emergency systems were found satisfactory. TransGrid's fire fighting capability is tested at its Annual TransGrid Safety Day, where skills of fire fighting staff from all Regions are tested under competition conditions.

5.8 Measures to Prevent Hazards to Community and Environment

In addition to the steps taken to identify hazardous events, their potential causes and consequences to staff and contractors, TransGrid through its range of design standards, maintenance policies, plant refurbishment and replacement strategies and operational work practices undertakes to address all foreseeable events relating to plant and processes that may cause hazards to the environment and community.

These issues are generally addressed in the parts 5.2 to 5.4 of this document and the NMP 01/06. Significant examples of these issues are:

(a) Analysis of environmental hazards is contained in TransGrid's *Environmental Management System* (Part 2.3 of NMP 01/06) and its *Environmental Manual* (document GD EN G2 002). These include a consideration of section 4.3.1 of ISO14001 for environmental aspects and impacts, and are summarised in an *Environmental Risk Register.* Relevant substations, transmission line and environmental standards address the issues raised in this process.

(b) The risks of bushfires associated with the management of transmission lines and their easements are fully addressed in TransGrid's *Bushfire Risk Management Plan*, a requirement of the Electricity Supply Safety and Network Management) Regulation 2002.

(c) Transformer fires and oil spills are major potential hazards to the community and environment. Should they happen, TransGrid maintains extensive safeguards to prevent these events from causing damage to the environment or community.

TransGrid's document GM EN G8 001 "Guide to Substation Oil Containment Design" sets out items to be considered in the design of substations with regard to spill containment systems and other places where bulk oil or liquid hazardous materials are kept.

Other substation and environmental standards, covered by 5.4 above, provide for the regular inspection of plant oil containment systems and emergency oil spill control equipment. Emergency response to a transformer fire, or fires of other causes, are managed by the process indicated in 5.7 above.

5.9 Demand Management

The Code requires TransGrid to treat non-network options, including demand management (DM) options, on an equal footing with network options when planning augmentations to the network. Thus consideration of DM options is fully integrated onto TransGrid's network planning processes.

At the implementation stage, TransGrid considers that DM options are best undertaken by third parties, who have the relevant expertise and resources. Thus, for a demand management option to be implemented to meet a network constraint it must, in addition to passing the ACCC's Regulatory Test, have a proponent who is committed to implement the option and to accept the associated risks, responsibilities and accountabilities.

At this point in time it is expected that DM options will emerge either from joint planning with distributors, Electricity Market participants or other interested parties. Reasonable DM options may include, but are not limited to, combinations of the following:

Reduction in electrical energy consumption through increased use, at points of end-use, of:

- Improved energy efficiency devices and systems;
- Thermal insulation;
- Renewable energy sources such as solar; and
- Alternative reticulated energy sources such as natural gas.

Reduction in peak electricity consumption through increased use, at points of end-use, of:

- Tariff incentives;
- Load interruption and reduction incentives;
- Energy storage systems;
- Standby generators; and
- Power factor correction equipment.

TransGrid actively promotes DM options through:

Identifying opportunities for DM options through joint planning with the Distributors and engaging expert external consultants.

Informing the market of constraints via its Annual Planning Report and consultations for alleviating individual constraints.

Participating in the review of the Demand Management Code of Practice for Electricity Distributors in NSW.

Participation in initiatives and reviews by the Ministry of Energy and Utilities and IPART that include consideration of demand management and its relationship to the development of electricity networks.

TransGrid's joint planning with the NSW distributors provides a mechanism to identify opportunities for DM options. The NSW distributors follow a similar process to TransGrid in preparing planning reports for their networks, thereby providing another useful source of information for proponents of DM options. They also follow a Demand Management Code of practice that details the steps to be followed in considering and implementing DM options in distribution planning.

An example of the outcomes of these activities is as follows. As part of the joint planning for electricity supply to the Sydney CBD and inner suburbs, TransGrid, Energy Australia and the Department of Urban and Transport Planning have initiated a high priority project to implement a Demand Management strategy to defer or avoid network expansion in greater Sydney area. The project will investigate and identify feasible demand management and local generation opportunities. TransGrid and Energy Australia are supporting the project by committing a total of $10 million towards a dedicated fund by contributing $1 million per year each over a five-year period.

5.10 Jurisdictional Planning Requirements

In addition to meeting requirements imposed by the National Electricity Code, environmental legislation and other statutory instruments, TransGrid is expected by the NSW jurisdiction to plan and develop its transmission network on an "n-1" basis. That is, unless specifically agreed otherwise by TransGrid and the affected distribution network owner or major directly connected end-use customer, there will be no inadvertent loss of load (other than load which is interruptible or dispatchable) following an outage of a single circuit (a line or a cable) or transformer, during periods of forecast high load.

In fulfilling this obligation, TransGrid must recognise specific customer requirements as well as NEMMCO's role as system operator for the NEM. To accommodate this, the standard "n-1" approach can be modified in the following circumstances:

- Where agreed between TransGrid and a distribution network owner or major directly connected end-use customer, agreed levels of supply interruption can be accepted for particular single outages, before augmentation of the network is undertaken (for example radial supplies).
- Where requested by a distribution network owner or major directly connected end-use customer and agreed with TransGrid there will be no inadvertent loss of load (other than load which is interruptible or dispatchable) following an outage of a section of busbar or coincident outages of agreed combinations of two circuits, two transformers or a circuit and a transformer (for example supply to the inner metropolitan/CBD area).
- The main transmission network, which is operated by NEMMCO, should have sufficient capacity to accommodate NEMMCO's operating practices without inadvertent loss of load (other than load which is interruptible or dispatchable) or uneconomic constraints on the energy market. At present NEMMCO's operational practices include the re-dispatch of generation and ancillary services following a first contingency, such that within 30 minutes the system will again be "secure" in anticipation of the next critical credible contingency.

5.11 Employee Competency System

To ensure that all TransGrid's employees and contractor staff who work on or near the systems electricity works have the appropriate competencies to undertake the work safely, TransGrid maintains and implements the following procedures and competency standards:

GD SA G2 021 – Occupational Health & Safety Training

GD SA G2 028 – Safety Rules Training, Assessment and Certification.

GM TT G2 004 – Network Training Policy

GM TT G2 001 – Substation Competency Standards

GM TT S2 102 – Protection & Metering Competency Standards

GM TT G2 007 – Safety Rules Competency Standards

In addition, TransGrid also implements the following National Training packages:

UTT98 – Electricity Supply Industry – Transmission & Distribution

UTE99 – Electro-technology Industry.

5.12 Public Liability Insurance

TransGrid secures public liability insurance to cover risks associated with its normal business operations. The insurance is sourced from both domestic and internationally based organisations. Responsibilities and procedures for this insurance are covered by TransGrid's document GD FN G2 019 "Insurance and Damaged Assets Procedures."

5.13 Superseding of Safety & Operating Plan

Following the issue of Electricity Supply (Safety Plans) Regulation 1997, TransGrid issued its *Safety and Operating Plan*, which is referred to in various locations of the Network Management Plan 2001-2006 (NMP 01/06).

With the enactment of the Electricity Supply (Safety and Network Management) Regulation 2002, the Electricity Supply (Safety Plans) Regulation 1997 is superseded and TransGrid's *Safety & Operating Plan* is also superseded, being replaced by this *Network Management Plan*.

References in Network Management Plan 2001-2006 (NMP 01/06) to the Safety & Operating Plan should be taken in the above context. When the NMP 01/06 is reissued, these references will be appropriately amended.

6. Schedule of Reports

TransGrid will, as required by notice in writing from the Director-General, lodge its Network Management Plan with the Director-General within such period as may be specified in the notice, to meet the requirements of Part 2 (Clause 5 [1a]), Part 2 (Clause 6), Part 4 (Clause 15) and Schedule 1 of the Electricity Supply (Safety and Management) Regulation 2002.

TransGrid will, at times required by the Director-General, provide the Director-General with a report from a nominated auditor to meet the requirements of Part 3 (Clauses 10, 11, 12, 13 and 14) of the Regulation 2002.

TransGrid will measure its performance against the Network Management Plan and an annual report will be provided to the Director-General as set out in Part 4 (Clause 16) of the Regulation 2002. The annual report will be in the form of the Electricity Network Performance Report submitted annually to the Ministry.

TransGrid will publish its Electricity Network Performance Report in accordance with Part 4 (Clause 16 [2 & 3]).

Network Management Plan 2001-2006

TransGrid

Network Management Plan 2001-2006

Contents

Introduction

The electricity industry in Australia has undergone significant change in the last five years with the separation of generation, transmission and distribution and the establishment of a national electricity market operator. These changes have been accompanied by the introduction of a national electricity code for market participants and the involvement of the Australian Consumer and Competition Commission in the setting of income and service standards for transmission network service providers such as TransGrid.

At State level there has been an increasing focus by shareholders and customers in the performance of transmission and distribution companies and in particular on reliability and availability of supply. This has been reinforced through the New South Wales Electricity Supply (Safety Plans) Regulation that requires Network Operators to develop Network Management Plans and to report annually on the performance of the network.

Against this backdrop TransGrid has reviewed and updated its 1998-2003 Network Management Plan to cover the five-year financial period from 2001 to 2006 inclusive. The Plan provides a focus for ongoing analysis within TransGrid and at continually improving the management of the transmission system. It also provides a formal method for information dissemination to customers, shareholders and regulators.

TransGrid's corporate objectives for electricity supply, safety, quality and the environment are achieved primarily through the strategies in this Plan. The Plan describes the model TransGrid uses to manage and develop its assets and the asset management strategies for network enhancement, maintenance and disposal. These strategies are integrated with non-asset strategies such as human resources, finance, information technology and procurement.

In many cases and in particular where network additions or augmentations are involved the need for such work is driven directly by customer needs and requirements. This Plan has been developed in parallel with an annual planning review conducted by TransGrid as the Jurisdictional Planning Body for New South Wales and therefore it will by necessity be a living document that will change in response to feedback from customers and market participants.

Feedback on this Network Management Plan in regards to either philosophy or detail is most welcome in order that TransGrid is able to continue to adjust its strategies to meet customer and stakeholder requirements.

D G Croft
Chief Executive

About TransGrid

About TransGrid

Our Objectives

- To provide accessible, efficient, safe and reliable facilities for the transmission of electricity
- To be commercially successful
- To be environmentally and socially responsible
- To identify the optimum solutions to provide reliable electricity supply

Our Mission

To be Australia's leading manager of network assets.

Values

In pursuing these initiatives, TransGrid will satisfy our customer and stakeholder needs and requirements by drawing on our values of:

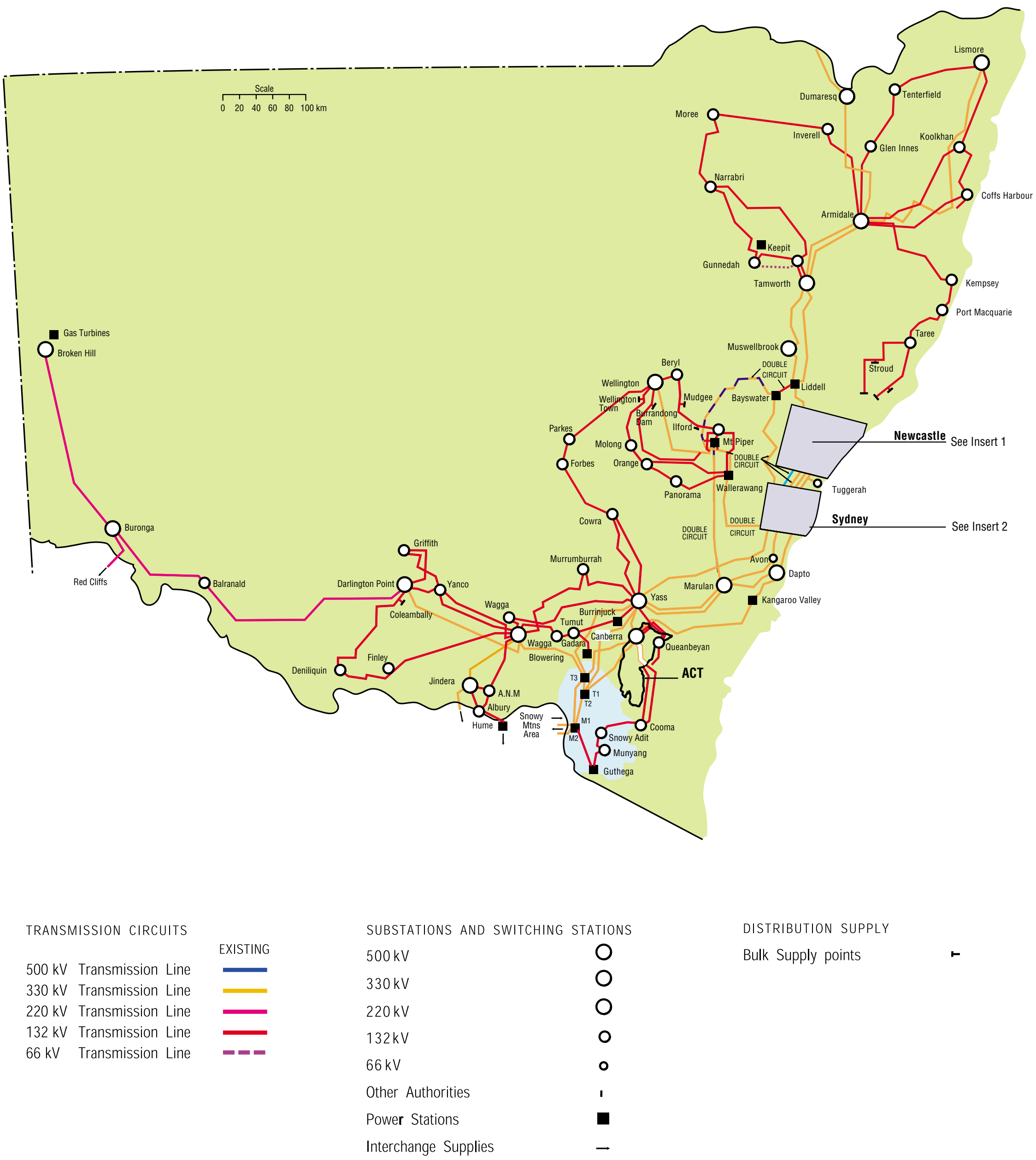
- Integrity
- Open Communication
- Trust and Respect
- Recognition of contribution
- Commitment to health and safety
- Competence

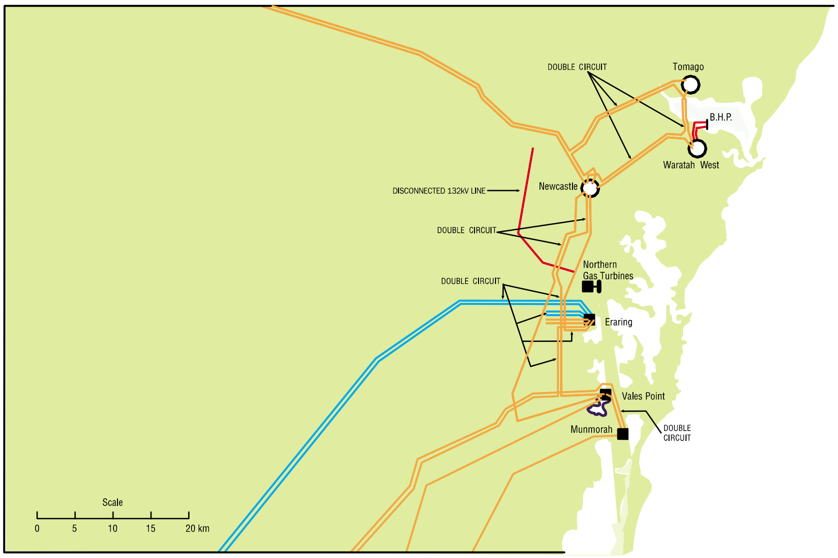
System Description

TransGrid is the owner, operator and manager of the high voltage transmission capability between generators, distributors and directly connected end users in New South Wales as well as interconnections with Queensland and Victoria. The system is a major part of one of the most extensive systems in the world comprising of 76 substations and power station switchyards and over 12,000 kilometres of transmission lines.

The system, which has a replacement value of more than $4 billion, operates at voltage levels of 500, 330,220 and 132kV. The substations are located on land owned by TransGrid and the transmission lines of steel tower, concrete or wood pole construction are generally constructed on easements acquired across private or public land.

TransGrid has staff strategically based at locations throughout NSW in order to meet the day to day operation and maintenance requirements as well as being able to provide emergency response. The main administrative office is located at the corner of Park and Elizabeth Street Sydney. Field staff are co-ordinated from major depots located at Wallgrove in western Sydney and at Newcastle, Tamworth, Orange, Wagga Wagga and Yass.

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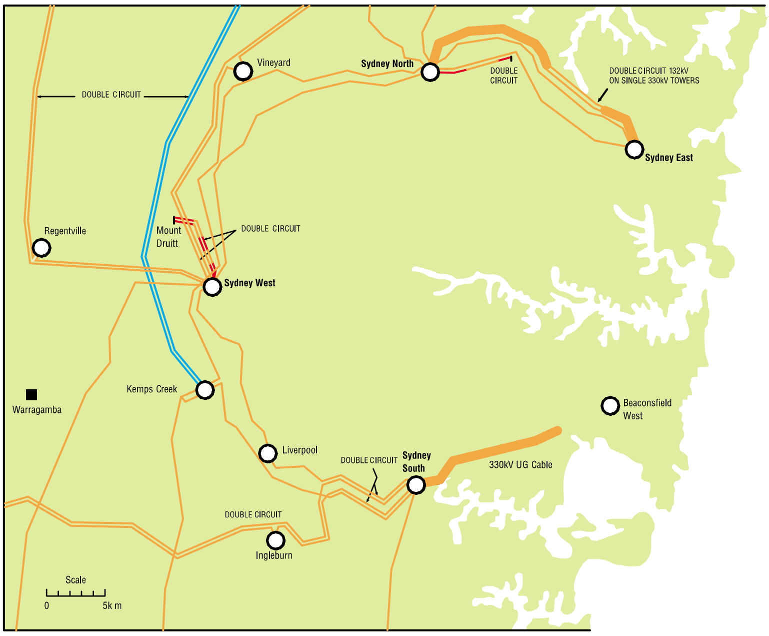
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1 Network Management Plan Framework

1 Network Management Plan Framework

1 Network Management Plan Framework

1.1 Introduction

In this latest Plan, TransGrid has moved from a pure asset management model to a broader model which it is believed more accurately reflects the approach that is to be taken in order for a high voltage transmission network to achieve its objectives. The intent is to recognise that in the high voltage electrical transmission business, planning of the network in relation to system augmentations and capacity upgrades plays just as an important role as managing the existing assets.

It also ensures from an organisational perspective that there is a corporate approach towards service standards as distinct from a pure engineering approach towards managing individual assets or groups of assets. For these reasons TransGrid is now managing its assets within a broader framework known as the "Network Management Plan".

The Network Management Plan integrates service delivery, planning, capital investment, operations and maintenance, replacement and disposal strategies. It is prepared to provide corporate direction to the organisation and to demonstrate responsible management of TransGrid's assets on behalf of its stakeholders and customers.

The Plan is TransGrid's statement of the resources and programs required to ensure that:

- Customers' requirements and service delivery continue to be met.
- The condition and performance of the assets are being maintained or improved to comply with TransGrid's standards and policies.
- The operating capability (and hence the value) of the network is being maintained.
- Occupational health and safety and environmental standards are maintained.

Within this framework the objective of the Network Management Plan is to provide a systematic approach to planning and managing assets thus ensuring that the condition and performance of the transmission and associated network assets is being effectively monitored, maintained and developed to meet customer and stakeholder expectations.

The Plan has a time horizon of five years looking forward initially from the 2001 – 2002 financial year and includes some tentative or long-term activities which extend beyond the five year planning horizon.

1.2 Customer, Stakeholders and Other Parties for which the Plan is prepared.

- TransGrid's customers are electricity distributors, retailers, generators, transmission network operators and directly connected end use customers.
- TransGrid aims to provide customers a safe, adequate and reliable transmission service and to deliver this over the long term, at minimum cost.
- TransGrid's stakeholder is the Government of NSW that wishes to ensure, as the ultimate owners of the assets, that their financial capital is secure.
- Other Parties with a potential interest in this Plan include employees and contractors who physically work on the assets, the members of the public through whose land the network is built, retailers and energy traders who use the network for trading and any of the regulatory bodies with which TransGrid comes into contact.

1.3 Structure of the Plan

The Plan specifically describes and details the planning and service delivery strategies and standards and the resulting capital investment strategy.

It also details the asset management strategies including the various policies, strategies and standards. It lists the programs for each of the asset categories detailing specific issues and the strategy for dealing with the issues. It also details the different measures used to determine the performance of the assets including technical performance assessments, quarterly asset performance reviews and benchmarking studies.

Asset disposal and waste strategies are also included in the most recent Network Management Plan.

1.4 Assets

The Plan covers all assets comprising or relating to the network including:

- Transmission Lines and Cables including easements and access tracks
- Substations and Switching Stations including all associated plant
- Communications equipment and associated facilities.

The Plan does not cover non-network assets such as motor vehicles, furniture and non-system related land.

1.5 Working Assumptions of this Plan

The Plan was prepared on the following basis:

- It is an overview document that leads to the preparation of more detailed working documents identified in the Network Management Process. These include the Annual Planning Statement, Asset Management Strategies, Maintenance Policies and capital and operating expenditure financial plans.
- It does not represent an authorisation to commit expenditure, nor does it represent a commitment on the part of TransGrid to proceed with any specific projects or programs - authorisation of expenditure will result from approval of the Annual Budget by the Board and from other specific expenditure, technical and environmental approvals.

1.6 TransGrid's Network Management Model

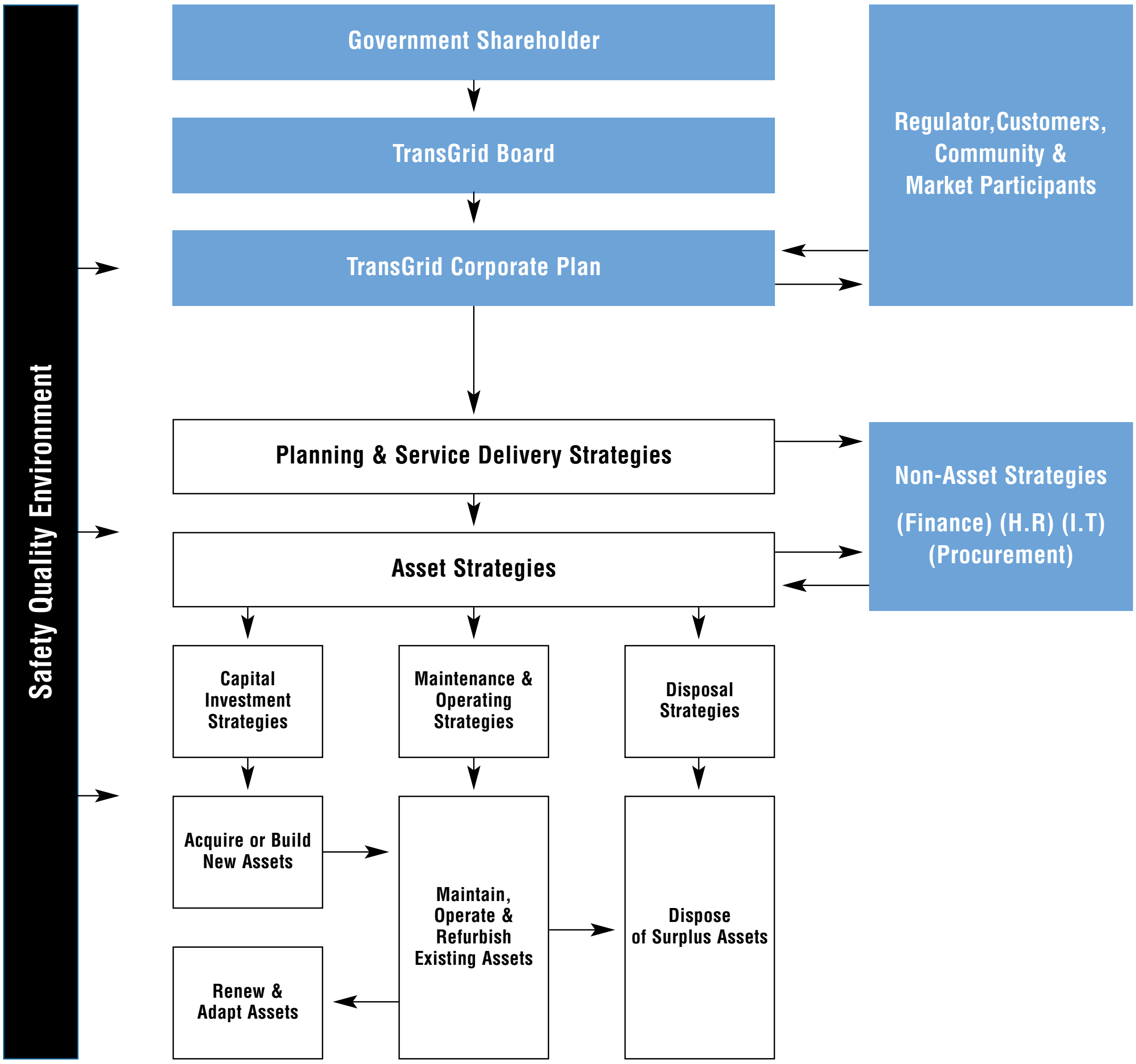
The Model shown on the next page provides a framework for the strategic planning and management of TransGrid's physical asset resources and is based on the New South Wales Government's Total Asset Management (TAM) Model.

The model shows the direct linkages between TransGrid's Corporate Plan and the components that make up the Network Management Plan.

1.7 Cost Base

The cost base for the Plan is based on Australian dollars as at 1st July 2001. To convert these figures to a projected actual expenditure for any given year, factors such as CPI and foreign exchange rate movements will need to be considered.

Network Management Model



The following table illustrates the relationships and linkages between specific aspects of TransGrid's Network Management Plan, associated strategies and related performance indicators. Ultimately, TransGrid's performance is judged against community, customer and shareholder expectations and the key performance indicators shown below are the parameters by which this performance could be assessed.

Output Performance	**Transgrid's Customer Service Delivery Standards, Statutory and Business Requirements.**		
	Capital Investment Strategies	**Asset Management Strategies**	**Asset Disposal Strategies**
Key Drivers	System adequacy to meet service delivery, load growth, quality of supply and security criteria. Design & construction standards.	Asset Performance.	Asset life expectation. Community and other legislative requirements.
Key Activities	Planning and development processes. Consultation processes. Construction of new assets.	Asset management strategies. Maintenance policies. Outage planning and cordination. Condition monitoring.	Asset equipment register to include materials such as pcbs. Identification of surplus assets. Waste mangement strategies.
Key performance indicators	Satisfy customer and system requirements incuding NEMMCO and ACCC. Network reliability and availability. Compliance with national electricity code. Completion of major capex projects to program and budget Safety and environmental incidents	Routine maintenance achievement Planned, forced and emergency outages (number and duration) Network reliability and availability Safety & environmental incicents	Develop and implement disposal plans Safe and cost effective disposal of surplus assets. Safety & environmental incidents

2 Management Support Systems

2 Management Support Systems

2.1 Quality System

2.2 Health and Safety Management System

2.3 Environmental Management System

2.4 Emergency Management System

2 Management Support Systems

The key deliverable for TransGrid is to manage its assets and resources in order to meet defined levels of performance in terms of cost, reliability, availability and quality. However the achievement of these objectives will at all times be performed so as not to compromise organisational commitments in regards to safety, the community and the environment.

In order to meet these requirements TransGrid's management plans and strategies are underpinned by the inter-relationships between TransGrid's Quality, Safety, Environmental and Emergency Management Systems.

Despite the large geographical distances between the Network Regions and their assets, TransGrid ensures confidence in the effective application of identical policies and practices across the network through maintaining its certification to AS/NZS ISO9001 for Quality Management and AS/NZS ISO14001 for Environmental Management Systems. To achieve the maintenance of both these certifications, TransGrid follows a 3 year cycle consisting of 6 monthly audits and a 3 yearly certification assessment by an appropriate Certification Body.

This section of the Plan describes these systems.

2.1 Quality System

2.1.1 TransGrid's Quality Policy

The quality system lays the foundation for TransGrid to achieve its objectives. TransGrid's Quality Policy is included in Appendix A.

2.1.2 Quality Certification

TransGrid demonstrates its on-going commitment to quality through its compliance with, and continuing external certification to ISO9001.

2.1.3 Quality System Organisational Structure

The Chief Executive is the ultimate authority for the Quality System within TransGrid, while direct overall responsibility is delegated to the General Manager/Commercial & Financial Services, reporting directly to the Chief Executive. Policy decisions regarding the implementation of a quality approach within TransGrid is determined by TransGrid Management.

Ensuring the flow through all levels of the organisation, Group and Region Managers have responsibility for the implementation of quality practices within their Group or Region and the quality of products and services provided by contractors.

Further, Team Leaders at all levels are responsible for ensuring that those activities under their control are carried out in accordance with established procedures.

As a consequence, TransGrid has confidence in the consistent application of quality procedures across its geographically diverse workforce.

2.1.4 Structure of Quality System Documentation

The back-bone of TransGrid's Quality System is its hierarchy of documentation. This documentation, under regular review to meet TransGrid's ongoing business activities, ensures that all the requirements of the elements of ISO9001 are met. The document hierarchy is as follows:

Quality Policy	• a statement of TransGrid's policy and objectives for quality
Quality Manual	• organisational structure • management responsibilities • quality system description
Corporate Procedures	• applicable to more than one Group/Business Unit • include procedures to control and implement activities so that business needs and the requirements of ISO9001 are met.
Asset Management Standards	• applicable to Network Business Unit only • set minimum requirements for the management of assets
Business Unit Documents	• cover specific needs for one Group/Region • include Group policies, broad procedures, work instructions, specifications, standards, manuals, forms and check sheets.
Project Specific Documents	• includes Project Plans, Design Plans, Contract Project Plans. • other documents for a specific project.

2.1.5 Overall Principles

TransGrid's quality approach provides its workforce with the tools and management support to:

- consistently deliver quality products and services which satisfy the customers' needs;
- improve organisation performance and eliminate waste by reforming work processes;
- work towards continuous improvement on all fronts; and
- deliver the right result first time.

2.2 Health and Safety Management System

2.2.1 Health and Safety Policy

TransGrid's Health and Safety Policy, GD HS G1 001 (Appendix A) reflects the organisation's commitment and underpins the Health and Safety management system.

2.2.2 Health and Safety Commitment and Principles

In addition to the Health and Safety Policy, TransGrid has developed a health and safety commitment and principles. They are as follows:

Commitment	• Our goal is zero injuries, occupational illnesses and incidents. We believe that all accidents are preventable on and off the job.
Principles	• Safety is our first priority • We will not budget for injuries • Working safely is a condition of employment • No shortcuts when it comes to safety • Management & Team Leaders demonstrate leadership in health and safety • Employees and contractors take ownership of safety by not accepting unsafe behaviour from anyone.

2.2.3 OH&S Organisational Structure

The Board of TransGrid has the final responsibility for ensuring that the necessary resources and organisational procedures exist throughout TransGrid. This responsibility is discharged through the Chief Executive and the Executive Occupational Health and Safety Committee.

Safety policies and procedures are approved by the Chief Executive following review and recommendation by the Executive Occupational Health and Safety Committee. The Executive Occupational Health and Safety Committee's charter is the development of corporate occupational health and safety policy and the promotion and monitoring of health and safety performance within TransGrid. The committee's goal is the elimination of all workplace injuries and accidents.

The Executive Occupational Health and Safety Committee has a number of subcommittees that report to it. These committees are:

- Fire Protection Committee
- Electric & Magnetic Fields Committee
- High Voltage Safe Working Practices Committee
- Safety Rules Committee
- Clothing Committee
- Safety Communications Steering Committee

Each of TransGrid's seven major sites has an established OHS committee. These committees meet every two/three months to address local issues and discuss endorsed recommendations of the Executive OH&S committee. An integral part of TransGrid's health and safety management system is the two yearly auditing of safety processes at each of our sites.

2.2.4 Health and Safety Management System

TransGrid's Health and Safety Management System is detailed in the document GD HS G2 020. It outlines TransGrid's organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining health and safety systems.

The document provides guidance to managers, team leaders and employees for the effective implementation and maintenance of health and safety systems and procedures in each of TransGrid's Business Units.

2.2.5 Safety Performance

TransGrid is required to report all fatal and non fatal accidents which involve electric shock, flash or burns or falls from elevated positions associated with work on electrical apparatus as soon as practicable to the Director-General, Ministry of Energy and Utilities.

TransGrid is also required to report to the Director-General, Ministry of Energy and Utilities any failure of equipment that could have consequences regarding the safety of staff, contractors or the public.

All accidents and safety incidents are investigated to ascertain causes and develop corrective and preventive measures to eliminate future occurrences. Any safety incident involving the general public is viewed as a most serious occurrence that involves thorough investigation.

Occupational health and safety performance data is provided as required by the Electricity Supply (Safety Plans) Regulation, 1997 in the format of NSW Electricity Network Management Report.

TransGrid's health and safety performance measures together with the previous 5 year trend are included in the annual Electricity Network Management Report provided to the Director-General.

2.2.6 Accident Statistics

TransGrid Staff:

Health and safety performance measures and statistics are recorded and maintained for employees in accordance with Australian Standard AS 1885. The following safety related statistics are kept and reviewed monthly:

(a) Number of Lost Time Injuries (LTI) within the period;
(b) Number of Non-Lost Time Injuries within the period;
(c) Lost Time Injury Frequency Rate;
(d) Average Lost Time Injury Rate;
(e) Number of work days lost due to LTI occurring within the period;
(f) Number of work days lost during the period due to all LTI;
(g) Number of days since last LTI.

Contractors:

TransGrid requires contractors to provide TransGrid with all details of any accident/incident occurring during the performance of the contract. In addition, TransGrid seeks periodic reports from contractors of the safety performance indicators as listed above.

A summary of Transgrid's lost time injury frequency rate is shown in the table below.

LTI Frequency	95/96	96/97	97/98	98/99	99/00	00/01
Employees	8.0	6.0	6.7	4.9	8.3	6.3

(no of accidents/million hrs worked)

The General Public:

Statistics are kept on public accidents and incidents and their causes together with prevention strategies.

2.2.7 Safety Rules, Equipment Design, Use and Maintenance

Operating and work procedures are contained in TransGrid Safety Rules - GD SA G2 012 which detail the rules for safe work on the transmission system, and System Control Operating Manuals which provide operation parameters for specific sites and operating practices and requirements to facilitate safe switching operations.

Safety equipment design, care, use, maintenance and frequency of maintenance, used by TransGrid employees and contractors, are detailed in TransGrid procedures:

GD SA G2 002	- High Voltage Operating Rods
GD SA G2 012.5	- Safeguards for Work on High Voltage Transmission Lines
GD SA G2 014	- Proving High Voltage Equipment De-energised
GD SA G2 015	- Portable earthing of High Voltage electrical equipment
GD SA G2 016	- Safeguards for Work on High Voltage Insulated Cables

Live Line Methods Manual - GM LL Series Documents.

As applicable, relevant Australian Standards and Codes of Practices are used in designing, selecting and maintaining equipment.

A range of Personal Protective Equipment (PPE) is used in TransGrid. PPE is selected with reference to relevant Australian Standards and Codes of Practice and by consultation with employees in the field.

2.2.8 Analysis of Hazards

Hazard Identification and Risk Assessment

TransGrid has in place a system to identify hazards and assess the risk of those hazards prior to commencing work on or near "electricity works". An analysis of hazards is carried out by TransGrid to ensure that protective and preventative measures have been implemented or are in place and are being followed.

A detailed analysis of hazard types, potential causes, possible consequences and measures implemented to ensure a safe system of work is provided as an Attachment to TransGrid's Health and Safety System GD HS G2 020.

Management review and auditing of the work of staff and contractors is carried out to ensure that any new hazards are appropriately identified and safe processes of work are implemented.

This hazard identification and risk assessment system is regularly audited to ensure compliance.

Hazards During New Construction Work

(a) New construction by contractors:

Major contractors to TransGrid are required to comply with the requirements of New South Wales Government OHS&R Management Systems Guidelines and to abide by the Codes of Practice and relevant TransGrid Policies and Procedures. The need to comply with relevant NSW Occupational Health and Safety Act and Regulations and environmental legislation is included in all contracts and orders.

Contractors, their staff and agents are required to be inducted onto a site and sign a declaration acknowledging that they have been advised of the relevant OH&S issues associated with the work to be undertaken.

(b) New construction by TransGrid:

TransGrid competes with external contractors for new construction work both within the organisation and in the external market. As part of this process, TransGrid will submit an OHS Management Plan for all new contracts as part of the tender documentation if required.

2.2.9 Emergencies

TransGrid's major Network Control Centres are staffed on a 24 hour basis. Operating staff at these centres are trained to operate the system in a safe manner in response to emergency conditions of all types, including:

(a) Fire, explosion, impact.

(b) Natural disaster.

(c) Civil disturbances.

In response to natural disasters and disturbances, the operator is required to contact the appropriate emergency service organisation e.g. Fire Brigade etc.

2.3 Environmental Management System.

2.3.1 Environmental Policy

TransGrid's Environmental Management System (EMS) is based on its Environmental Policy, a copy of which is in Appendix A.

Main aspects of TransGrid's Environmental Policy include:

- compliance with all relevant environmental statues, regulations and standards;
- operating an environmental management system; and
- ensuring that environmental factors are taken into account for each activity.

It is the responsibility of all TransGrid staff to be active in the protection of the environment, to consult with the community as appropriate and to undertake relevant training.

Regular environmental audits are carried out to ensure the compliance with TransGrid environmental policies and standards.

2.3.2 Environmental Commitment and Certification

Reflecting its Policy, TransGrid has developed and implemented an EMS in accordance with the requirements of AS/NZS ISO 14001. TransGrid's EMS was certified as complying with AS/NZS ISO 14001 in 1996.

The EMS is part of TransGrid's overall business management system. It is a framework within which specific procedures, objectives and targets are developed, implemented, audited and reviewed. The EMS enables TransGrid to demonstrate its commitment to sound environmental management, compliance with statutory requirements and to the principle of continual improvement.

2.3.3 Environmental Organisational Structure

The Board of TransGrid has the final responsibility for ensuring that the necessary resources and organisational procedures exist throughout TransGrid. This responsibility is discharged through the Chief Executive and the Executive Environmental Committee.

Environmental policies and procedures are approved by the Chief Executive following review and recommendation by the Executive Environmental Committee. The Executive Environmental Committee has as its purpose the development of corporate environmental policy and the promotion and monitoring of environmental performance within TransGrid.

An integral part of TransGrid's environmental system is the two yearly auditing of related processes at each of our sites.

2.3.4 TransGrid's General Environmental Principles

- TransGrid is committed to minimising the environmental impacts of its activities.
- Protection of the environment is the responsibility of all staff. Each staff member has the authority to undertake action to protect the environment, to report any environmental incidents and to identify any environmental hazards or potential hazards, to the extent of his or her responsibility.
- Each Group within TransGrid shall consider environmental issues as part of their business planning, monitoring and reporting processes.
- TransGrid activities will be carried out in a lawful manner and in full compliance with the requirements of relevant Acts and Regulations in force at the time.
- Changes to procedures or practices will conform to the objective of continuing improvement, aiming to maximise positive environmental impacts.
- Adverse environmental impacts of activities will be minimised, within the constraints of technical and economic factors.
- TransGrid activities will be carried out with consideration for the environmental responsibilities of other agencies, such as the Environment Protection Authority, National Parks & Wildlife Service, Department of Land and Water Conservation, NSW Forests, Heritage Council, local councils and owners of property affected by TransGrid easements.
- Specific objectives and targets will be set against which the organisation's performance can be audited.

2.3.5 Elements of ISO 14001 and TransGrid's EMS

The aim of an EMS is to effectively manage the environmental aspects of an organisation's operations, to ensure minimum environmental impact.

AS/NZS ISO 14001 "Environmental Management Systems – Specification with guidance for use" describes seventeen elements that are required in an EMS which are intended to lead to continual improvement in performance. These elements are:

1. Environment Policy
2. Environmental Planning – Aspects and Impacts
3. Environmental Planning - Legal and Other Requirements
4. Environmental Planning - Objectives and Targets
5. Environmental Planning - Environmental Management Program
6. Implementation and Operation - Structure and Responsibilities
7. Implementation and Operation - Training, Awareness and Competence
8. Implementation and Operation – Communication
9. Implementation and Operation - EMS documentation
10. Implementation and Operation - Document control
11. Implementation and Operation - Operational control
12. Implementation and Operation - Emergency Preparedness and Response
13. Checking and Corrective Action - Monitoring and measurement
14. Checking and Corrective Action - Nonconformance and corrective and preventive action
15. Checking and Corrective Action – Records
16. Checking and Corrective Action - Environmental management system audit
17. Management review

TransGrid, in its Environmental Plan GD EN G2 007 sets out its response to each of these seventeen elements of ISO 14001 and also the Business Units responsible for those elements.

2.4 Emergency Management System

TransGrid has developed a Corporate Emergency Management Plan (CEMP) to co-ordinate the management measures necessary to ensure a state of preparedness for emergencies which may impact upon reliability of supply, the safety of staff, members of the public or the environment. The CEMP is also required to respond to emergencies declared under the NSW State Disaster Plan (Displan).

The CEMP categorises the various levels of emergency and details the specific command structures and responsibilities associated with each.

Each of TransGrid's Regions have similar Emergency Response Plans detailing the local command structures and responsibilities. These Plans are tested annually with a simulated emergency carried out in conjunction with other organisations to ensure they are effective in handling a range of situations.

All the above mentioned plans are reviewed following any significant emergency to ensure that they were applied, that they worked effectively and noting any areas requiring amendment.

Site Emergency Response Plans are also developed which detail site evacuations and emergency procedures. These plans comply with Australian Standard - AS 2.5745 Emergency Control Organisation and Procedures for Buildings.

These plans detail the site emergency control personnel, evacuation measures including annual training exercises, debrief session and the testing of alarms. All visitors to sites are advised of the existence of these procedures as part of their site induction.

3 Planning and Service Delivery

3 Planning and Service Delivery

3.1 Corporate Planning

3.2 Network Planning

3.3 Service Standards and Asset Performance

3 Planning and Service Delivery

3.1 Corporate Planning

The understanding of stakeholder, customers, regulators, market participants and the community is essential in developing a corporate plan and in turn enabling TransGrid to define the appropriate planning methodology and service standards.

As mentioned in the Introduction there has been an increasing concern by shareholders and customers in the performance of utilities in terms of service standards, safety and the environment. For TransGrid, as a State owned corporation and a regulated monopoly provider of transmission services, there is also a range of Acts, Regulations and Codes that impact upon network planning and therefore service delivery. TransGrid's customers are also able to input into the planning process and to have a direct involvement in the determination of service standards through regulatory, consultative and Connection Agreement processes.

TransGrid's planning process is subject to several external agencies, that determine the regulatory and planning processes. Consequently the delivery of service standards is dependent on the planning process as well as the service standards themselves. By way of comparison, in a competitive environment, service standards or service performance would normally drive planning and capital investment.

Within the National Electricity Market framework, TransGrid's regulator, the Australian Competition and Consumer Commission and the National Electricity Code have prescribed a set of service standards that are consistent with past practice and international benchmarked best practice.

Despite not having primary control over the planning process, TransGrid has agreed with its regulator, the Australian Competition and Consumer Commission, to a set of service standards that are consistent with past practice and international benchmarked best practice.

3.2 Network Planning

3.2.1 Objectives

Planning and development of TransGrid's network is undertaken in accordance with the National Electricity Code. The Code sets out processes that require TransGrid to consult with Code Participants and interested parties on development options (which must include consideration of demand side management and local generation options) and apply the ACCC's Regulatory Test to determine the most economic option.

The Code also specifies performance requirements of the network that form part of TransGrid's service standards.

Accordingly TransGrid plans to develop its network so that it:

- provides adequate power transmission capability;
- provides electricity supply whose quality and reliability are determined by its customer service standards;
- provides a standard of connection to individual customers determined by Connection Agreements;
- ensures that, as far as possible, connection of a customer has no adverse effect on other connected customers;
- satisfies environmental constraints;
- maintains acceptable safety standards; and
- is developed in accordance with the Code and the ACCC's regulatory test for regulated network augmentations

3.2.2 Main Activities

The main activities that support planning and development of the network include:

- Load forecasting;
- Identification of network constraints;
- Justification and regulatory assessment of development options;
- Joint Planning with electricity distributors and other major customers;
- Annual Planning Review for New South Wales; and
- Input to capital works budget.

3.2.3 Load Forecasts

A major input to planning is the forecast of electricity demand and energy consumption.

There are three levels of load forecast used by TransGrid:

- an overall State demand and energy forecast;
- a local supply point forecast; and
- an aligned major substation forecast.

The overall State demand and energy forecast is developed based on historical demands, economic and demographic scenarios and temperature variables. The economic scenarios are provided by NEMMCO to all jurisdictions to ensure a common basis for these forecasts. The State forecast is produced each year in time for inclusion in NEMMCO's annual Statement of Opportunities.

To cater for regional and local needs, a forecast of the demand at each supply point is developed based on forecasts supplied by the electricity Distributors and major customers. These forecasts thus take account of demand management programs in place or foreseen by Distributors. Account is taken of load diversity between connection points. The forecasts generally cover both summer and winter demands and extend over a planning horizon of ten years.

To analyse conditions on the main network a forecast is developed which aligns the local and overall state forecasts to provide a range of forecast demands at each substation, for both winter and summer. The aligned forecasts apply under the following conditions:

- demands coincident with the overall system peak demand;
- demands coincident with the peak demand in the subsystem of the main network containing each substation; and
- peak demand on the individual substations.

3.2.4 Identifying Network Constraints

An emerging constraint may be identified during various planning activities such as:

- Connection enquiries
- ongoing network analysis of present and future performance and related activities;
- joint planning with Distributors;
- the impact of prospective generation developments;
- the impact of network developments undertaken by other TNSP's; or
- as a result of a major load development.

Connection enquiries and the formulation of draft connection agreements lead to a preliminary review of the capability of connections. Further discussions are held with specific customers where there is a need for augmentation or for provision of new connection points.

Network analysis is undertaken at two levels:

1. Network Planning within the New South Wales Region

The main 500 kV, 330 kV and 220 kV transmission system is developed in response to the overall load growth and generation requirements and may be influenced by interstate interconnection power transfers. Development includes negotiation with affected NSW and interstate parties.

2. Inter-regional Planning

The development of interconnectors between regions, and of augmentations within regions that have a material effect on inter-regional power transfer capability are coordinated, under the National Electricity Code, by the Inter-regional Planning Committee convened by NEMMCO. Network Service Providers may also apply to NEMMCO for interconnection works to be price-regulated. The IRPC conducts an annual planning review of the inter-regional networks, and assists NEMMCO in assembling the annual Statement of Opportunities. This document identifies actual and potential constraints on the networks that may be addressed by transmission augmentations, generation developments or demand management developments. A timetable for addressing inter-regional constraints follows from this work.

3.2.5 Identification and Regulatory Assessment of Options

During the initial planning phase a number of options for addressing constraints are developed. In accordance with Code requirements consultation with interested parties is carried out to determine a range of options including network, local generation and DSM options and/or refine existing options.

A cost effectiveness analysis is carried out in which the costs and benefits of each option are compared in accordance with the ACCC's Regulatory Test. In applying this test the cost/benefit factors may include:

- avoiding unserved energy caused by either a generation shortfall or inadequate transmission capability or reliability;
- loss reductions;
- alleviating constraints affecting generation dispatch;
- avoiding the need for generation development;
- fuel cost savings;
- improvement in marginal loss factors;
- deferral of related transmission works; and
- reduction in operation and maintenance costs.

Options with similar Net Present Value would be assessed with respect to factors that may not be able to be quantified and/or included in the Regulatory Test, but nonetheless may be important from environmental or operational viewpoints, such as:

- reduction in greenhouse gas emissions or increased capability to apply greenhouse-friendly plant;
- improvement in quality of supply above minimum requirements; and
- improvement in operational flexibility.

3.2.6 Joint Planning with Distributors and Major Customers

TransGrid conducts both regular (at least annually) and ad-hoc joint planning activities with all of its major customers, including Distributors, and requires each Distributor to provide a load forecast covering its franchise service area in time for preparation of the Annual Planning Statement.

The purpose of these activities is to identify emerging network constraints at points of connection between TransGrid's and the Distributors' networks and to identify optimum solutions.

3.2.7 Annual Planning Review for New South Wales

The New South Wales Minister for Energy requires that TransGrid, as the Jurisdictional Planning Body for New South Wales, carry out an Annual Planning Review for New South Wales. The purpose of the Review is to focus on an optimum level of transmission investment by encouraging interested parties to propose options for the relief of transmission constraints that may involve components of local generation and DSM. The Review includes a public forum at which the Annual Planning Statement for New South Wales is presented and discussed.

The first Annual Planning Review was held during 2000 and the Review for 2001 is in progress.

3.2.8 Transmission Planning Criteria

3.2.8.1 General

TransGrid's approach to network planning has been formulated to achieve appropriate reliability standards satisfying Code obligations and Connection Agreement obligations while meeting supply requirements at optimum costs. It is consistent with both the National Electricity Code (the Code) and its customer service obligations.

In particular, the reliability criteria applied to planning ensure that, for credible system contingencies, there is a high probability that:

- load will not be shed, except for that which may be offered to the market as dispatchable or interruptible;
- the energy market will not be uneconomically constrained;
- the electrical and thermal ratings of equipment will not be exceeded;
- stable control of system voltage will be maintained, with system voltages maintained within acceptable levels;
- stable control of system frequency will be maintained, with frequency within acceptable levels; and
- synchronous stability of the interconnected power system will be maintained.

The development of TransGrid's network is planned on the basis of the economic evaluation of options to provide a defined level of supply reliability. This involves the application of a deterministic criterion in conjunction with a probabilistic-based approach to the analysis of system adequacy and security. This approach is used widely in international practice.

Although there is a high probability that loads will not be shed as a result of system disturbances no power system can be guaranteed to deliver a firm capability 100% of the time, particularly when subjected to disturbances that are severe or widespread. In addition extreme loads, above the level allowed for in planning, can also occur, usually under extreme weather conditions.

Thus there is a potential for low probability events to cause localised or widespread disruption to the power system. These events include the following:

- loss of several transmission lines within a single corridor, as may occur during bushfires;
- loss of a number of cables sharing a common trench;
- loss of more than one busbar within a substation, possibly following a major plant failure;
- loss of a number of generating units; and
- occurrence of three-phase faults, or faults with delayed clearing.

In TransGrid's network appropriate facilities and mechanisms are frequently put in place to ameliorate the impact of such events. The decision process considers the underlying economics of facilities or corrective actions, taking account of the low probability of the occurrence of extreme events.

The assessment of TransGrid's transmission network is governed by existing or emerging constraints in the areas of:

- line and transformer thermal ratings;
- transient and steady state stability;
- control of voltages, including voltage stability; and
- equipment fault ratings.

Appropriate allowance must also be made for sufficient capability in the system to allow components to be maintained in accordance with TransGrid's asset management strategies.

Transmission planning seeks to take advantage of the latest proven technologies in electrical plant and control systems where these are found to be economic. For example, the application of static var compensators has had a considerable impact on the power transfer capabilities of parts of the main grid and has deferred or removed the need for transmission line development.

The broad approach to consideration of these technologies together with related issues of protection facilities, transmission line design, substation switching arrangements and power system control and communication is set out in the following sections. This approach is in line with international practice and provides for cost effective means of maintaining a safe, reliable, secure and economic supply system with a responsible approach to consideration of environmental and social impacts.

3.2.8.2 Code Requirements

The Code specifies requirements relating to planning standards in a range of areas including:

- a definition of the minimum level of credible contingency events to be considered;

  These include the disconnection of any single generating unit or transmission line, with or without the application of a single circuit two-phase-to-ground solid fault on lines operating at above 220 kV, and a single circuit three-phase solid fault on lines operating below 220 kV.

  The fault is to be assumed cleared in primary protection time or by the faster of the duplicate protections with installed intertrips available.

  The Code provides for the consideration of a two-phase-to-earth fault criterion on transmission lines operating below 220 kV but above 66 kV if the modes of operation are such as to minimise the probability of three-phase faults occurring. TransGrid's operational experience shows this to be adequate.
- the need for two independent high speed protection systems;
- the power transfer capability during the most critical single element outage. This can range from zero in the case of a single element supply to a portion of the normal power transfer capability.
- frequency variations;
- magnitude of power frequency voltages;
- voltage fluctuations;
- voltage harmonics;
- voltage unbalance;
- voltage stability;
- synchronous stability;
- damping of power system oscillations;
- fault clearance times;
- automatic reclosure of overhead transmission lines; and
- rating of transmission lines and equipment.

3.2.8.3 Deterministic Planning Criteria

In addition to adherence to Code and regulatory requirements, TransGrid's transmission planning approach has been developed taking into account the historical performance of the components of the NSW system, the sensitivity of loads to supply interruption and state of the art asset maintenance procedures.

A set of deterministic criteria, detailed below, are applied as a point of first review, from which point a detailed assessment of each individual case is made. Both Monte Carlo-based and analytical methods are applied to assess the adequacy of the transmission system.

Main Transmission Network

Power flows on the main transmission network are subject to overall state load patterns, dispatch of generation within the National Electricity Market including interstate export and import of power and the availability of Ancillary Services. NEMMCO applies operational constraints on generator dispatch to maintain power flows within the capability of regional networks. These constraints are based on the ability of the networks to sustain certain credible contingency events that are defined in the Code. These events mainly cover forced outages of single generation or transmission elements, but also provide for multiple outages to be redefined as credible from time to time. Constraints are usually based on short-duration loadings on network elements, on the basis that generation can be re-dispatched within 15 minutes.

The rationale for this approach is that, if operated beyond a defined power transfer level, disturbances could potentially lead to system wide loss of load with severe social and economic impact.

Following any transmission outage, for example during maintenance or following a forced outage for which reclosure has not been possible, NEMMCO applies even more severe constraints within a short adjustment period, in anticipation of the impact of a further contingency event. This may require the re-dispatch of generation and dispatchable loads, the re-distribution of ancillary services and, where there is no other alternative, the shedding of load. NEMMCO would therefore direct the shedding of customer load, rather than operate for a sustained period in a manner where overall security would be at risk for a further contingency. The risk is, however, accepted over a period of up to 30 minutes.

TransGrid's planning for its main network therefore concentrates in the first instance on the security of supply to its load connection points under sustained outage conditions, so as to maintain the overall principle that supply to load connection points must be secure after any single contingency. Although TransGrid performs much of its transmission line maintenance using live line techniques, provision must be made for outages of line and terminal equipment in accordance with TransGrid's asset management plan. In performing its analysis TransGrid must consider the imperative that NEMMCO will operate the network in a secure manner as described.

The analysis of network adequacy requires the application of probabilistic-based security analysis, taking into account the probable load patterns, typical dispatch of generators and loads, the availability characteristics of generators as influenced by maintenance and forced outages, energy limitations and other factors relevant to each case. Options to address an emerging inability to meet all connection point loads would be considered at or before the planning horizon for a network augmentation solution.

Further consideration may be given before this time to the costs involved in re-dispatch in the energy and ancillary services markets to manage a single contingency as described above. In situations where these costs appear to exceed the costs of a network augmentation this will be brought to the attention of network load customers for consideration.

Although the issues of inter-regional transmission, interconnectors and the creation of Regions in the market are beyond the scope of the Annual Planning Statement, some discussion is warranted because of the need to define the relationship between jurisdictional and inter-regional planning.

The ability of TransGrid's network to provide market access to Generators, other than that required to ensure reliable supply to loads, is not specifically considered in this document because these matters are subject to commercial negotiation in accordance with clause 5.5 of the Code.

Relationship with Inter-Regional Planning

Under the provisions of the Code NEMMCO may recommend the creation of a Region where constraints to generator dispatch are predicted to occur with reasonable frequency with the network operated in the "system normal" (all significant elements in service) condition. In making this recommendation the Code currently does not require NEMMCO to consider either the size of the price difference that is likely to occur, or the consequences to load connection points if there should be a network contingency. In effect the capacity of interconnectors that is quoted is the short-time capacity determined by the ability to maintain secure operation after a single contingency in the system normal state. The operation of the interconnector at this capacity must be supported by appropriate ancillary services, but NEMMCO does not operate on the basis that the contingency may be sustained.

Networks Supplied from the Main Transmission Network

Some parts of TransGrid's network are primarily concerned with supply to loads, and are not impacted by the marginal dispatch of generation (although they may contain embedded generators). Further, the loss of a transmission element does not have to be considered by NEMMCO in determining network constraints, although ancillary services may need to be provided to cover load rejection in the event of a single contingency.

Urban and Suburban Areas Joint Planning

Generally the urban and suburban networks are characterised by a high load density served by high capacity underground cables and relatively short transmission lines. The connection points to TransGrid's network are usually the low voltage (generally 132 kV) busbars of 330 kV substations. There may be multiple connection points and significant capability on the part of the Distributor to transfer load between connection points, either permanently or to relieve short-time loadings on network elements after a contingency.

The focus of joint planning with the Distributor is the capability of existing connection points to meet expected peak loadings, and the need for augmentation to TransGrid's connection point capacity or to provide a new connection point where this is the most economic overall solution. TransGrid's aim is to provide a level and reliability of supply at connection points that is complementary to that provided by the Distributor within its own network.

Consistent with this TransGrid aims to provide 'n-1' reliability at the peak demand of the supply point that is forecast to be exceeded one year in two. It should be noted that 5-10 MW is about the load forecast resolution at a large connection point. "One year in ten" peak loadings will also be considered, but an augmentation will only be advanced where there is no possibility of securing the additional load by switching between connection points.

Supply to high-density urban and central business districts requires special consideration in accordance with good international practice. For example the inner Sydney metropolitan network serves a large and important part of the State load. Supply to this area via the 330 kV and 132 kV underground cable network is planned to be secure against the outage of a single 330 kV cable or 330/132 kV transformer in TransGrid's network and a simultaneous outage of the most critical 132 kV cable in the EnergyAustralia's network. Thus an 'n-1' criterion is applied separately to the two networks. This based on consideration of the following factors:

- the importance and sensitivity of the Sydney area load to supply interruptions;
- the high cost of applying a strict 'n-2' criterion to the 330 kV cable network;
- the large number of elements in the 132 kV network;
- the past performance of the cable system; and
- the extensive outage time that can result from a cable failure.

The criterion applied to the Sydney area is consistent with that applied in the electricity supply to major cities throughout the world. Most countries use an 'n-2' criterion. Some countries apply an 'n-1' criterion with some selected 'n-2' contingencies that commonly include two cables sharing the one trench or a double circuit line.

Outages of network elements for planned maintenance must also be considered. Generally this will require 75% of the peak load to be supplied during the outage. While every effort would be made to secure supplies in the event of a further outage, this may not be always possible. In this case attention would be directed to minimising the duration of the outage.

Non Urban Areas Joint Planning

Generally these areas are characterised by lower load densities and, generally, lower reliability requirements than urban systems. The areas are often supplied by relatively long single circuit transmission systems. Connection points are either on 132 kV lines or on the low voltage busbars of 132 kV substations. Although there may be multiple connection points to a Distributor they will usually be far apart and there will be little capacity for power transfer between them. Frequently supply limitations will apply to the combined capacity of several supply points together.

The focus of joint planning with the Distributor will usually relate to augmentation of connection point capacity, duplication of radial 132 kV lines, the extension of the 132 kV system to reinforce or replace existing lower voltage systems and to reduce losses and the overlay of a higher voltage system to provide a major augmentation and to reduce network losses.

Supply to one or more connection points would be considered for augmentation when the firm 'n-1' capacity of TransGrid's network is forecast to be exceeded at peak load at the planning horizon. Consistent with the lower level of reliability that may be targeted by the Distributor in a non-urban area the augmentation would be undertaken before more than 3% of the load would be at risk at the peak period one year in two, or where the period at risk exceeds 1% of the time (88 hours per year).

Economics often dictate that an extension of the 132 kV system will not be justified until there are at least two lower voltage lines (usually 66 kV or 33 kV) to an area, and these subsequently provide backup to the single 132 kV line. An exception would be made for supply to a new single point load.

An area supplied by a radial 132 kV line backed up by a lower voltage network would be reviewed for duplication when the area load at risk exceeds about 10 MW.

As a result of the application of these criteria some radial parts of the 330 kV and 220 kV network are not able to withstand the forced outage of a single circuit line at time of peak load, and in these cases provision has been made for under-voltage load shedding.

Provision is also required for the maintenance of the network. Additional redundancy in the network is required where maintenance cannot be scheduled without causing load restrictions or an unacceptable level of risk to the security of supply.

Transformer Augmentation

In considering the augmentation of transformers appropriate allowance is made for the transformer cyclic rating and the practicality for load transfer between connection points. The outage of a single transformer (or single-phase unit) or a transmission line which supports the load carried by the transformer is allowed for.

Provision is also required for the maintenance of transformers. This has become a critical issue at a number of sites in NSW where there are multiple transformers in-service. Additional transformer capacity may be required or alternatively a means of support to the load via the underlying lower voltage network.

3.2.8.4 Input To Capital Investment Strategy

Planning activities provide a key input to TransGrid's capital investment strategy by forming the basis of the 5 year capital budget relating to investment in increased capacity of the network.

Details of capital investment estimates that relate to extensions of TransGrid's network to meet emerging constraints that have been identified during planning activities, are provided in Section 4.1 of this document.

3.3 Service Standards and Asset Performance

Internationally there are a range of service standards that are used to assess the performance of transmission networks. These include cost, reliability of supply, availability of the network, forced outages and equipment performance.

An individual organisations' performance in any one of these performance measures is very much dependent on a variety of factors such as planning criteria, external environment, asset age, funding and technology. Accordingly "best practice" for an organisation may not necessarily result in the particular organisation being a "best performer" when benchmarked.

3.3.1 Network Reliability

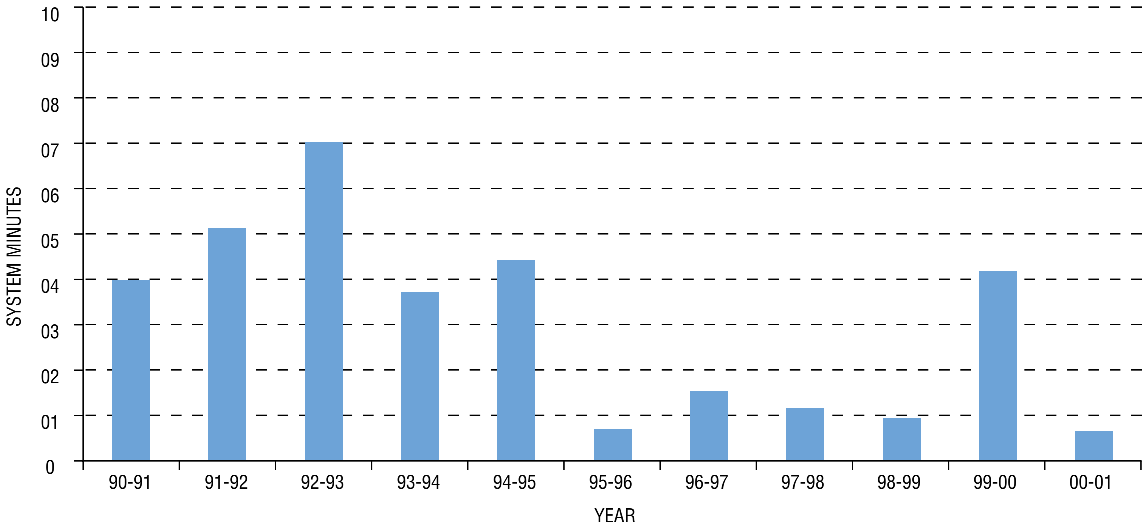
Reliability is a measure of the service level of the transmission network as perceived by the customer. It relates to the amount of Energy Not Supplied resulting from a temporary failure of a component of the network. The measure used to describe Reliability is System Minutes where

$$\text{System minutes} = \frac{\text{Energy not supplied (MWh) x 60}}{\text{Annual system maximum demand}}$$

TransGrid's objective is to use all reasonable and practicable efforts to minimise the number and duration of unplanned interruptions. Accordingly, TransGrid aims to contain system minutes resulting from the combined number and duration of interruptions experienced to between 0.5 and 2.0 system minutes per annum, with a rolling 3 year average of less than 1.3 system minutes.

The graph opposite shows TransGrid's reliability performance since 1990:

Network Reliability



Of the 4.23 System Minutes total for 1999/2000, 3.72 System Minutes were a result of two non-typical outages the details of which are as follows:

i) 1.62 System Minutes that affected the north east of NSW in January 2000, was a result of a forced outage of a transformer at Armidale substation at the time that other equipment was out of service for major capital works.

ii) 2.1 System Minutes that affected the far south west of Sydney in January 2000, was a result of fire within the roof of the control building at Ingleburn substation. This was the first such incident within TransGrid's long history.

Without these two incidents the Network Reliability figure for 1999/2000 would have been 0.51 System Minutes.

The Network Reliability figure for 2000/2001 was 0.67 System Minutes.

In addition, within TransGrid the service standards for Reliability are cascaded down to individual customers and provide further details of performance at each supply point. A summary of this performance is given in the tables below.

Loss of Supply in MWh per Customer per Year

	ACTEW	Australian Inland Energy	ANM	BHP	Country Energy	Energy Australia	Integral Energy	State Rail Authority	Tomago Aluminium	Visy Paper
1997/98	0	16	0	6.7	60.48	44.25	48.33	0	51	0
1998/99	0	22	0	0	56.6	21.25	5.3	0	72	0
1999/00	0	5.9	0	0	406.62	0	404.3	0	0	0
2000/01	0	0	0	0	99.05	0	15.5	0	0	14

Number of Interruptions Involving Loss of Supply per Customer per Year

	ACTEW	Australian Inland Energy	ANM	BHP	Country Energy	Energy Australia	Integral Energy	State Rail Authority	Tomago Aluminium	Visy Paper
1997/98	0	1	0	1	12	2	1	0	1	0
1998/99	0	1	0	0	5	1	1	0	1	0
1999/00	0	1	0	0	8	0	1	0	0	0
2000/01	0	0	0	0	5	0	1	0	0	2

Number of Interruptions per Customer per Year divided by Number of Supply Points to that Customer

	ACTEW	Australian Inland Energy	ANM	BHP	Country Energy	Energy Australia	Integral Energy	State Rail Authority	Tomago Aluminium	Visy Paper
1997/98	0	0.5	0	1	0.23	0.182	0.08	0	1	0
1998/99	0	0.5	0	0	0.1	0.09	0.08	0	1	0
1999/00	0	0.5	0	0	0.15	0	0.08	0	0	0
2000/01	0	0	0	0	0.09	0	0.08	0	0	2

3.3.2 Circuit Availability

Circuit availability is generally expressed as a percentage of time the transmission system is in an operating state, with 100% indicating no network outages.

Circuit availability is calculated as follows:

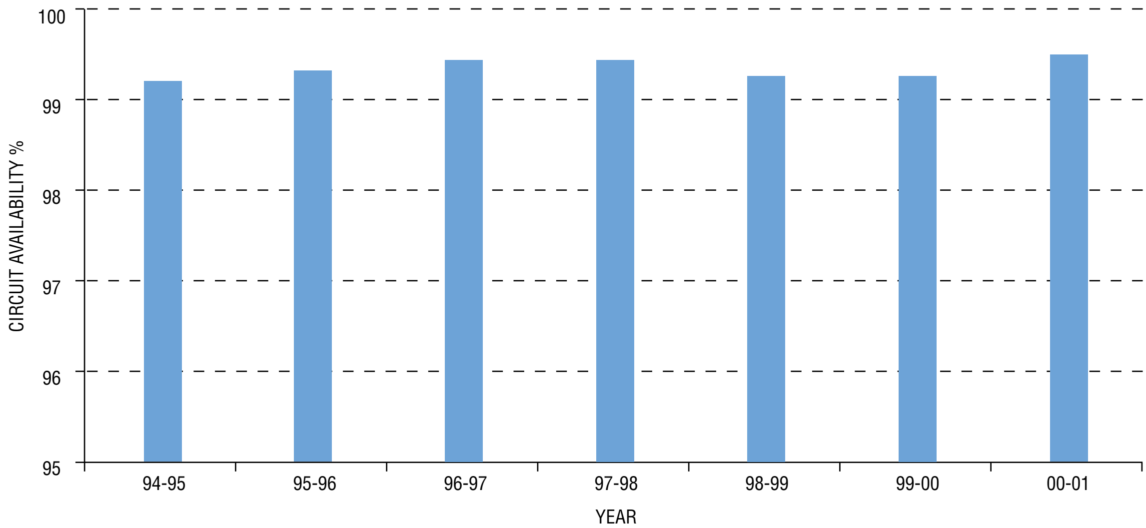
$$\text{Circuit availability (\%)} = \frac{100 \text{ x sum of available hours for each circuit}}{8760 \text{ x no. of circuits}}$$

In this calculation the denominator represents the total sum of possible circuit hours available.

TransGrid's objective is to use all reasonable and practicable efforts to minimise the number and duration of planned and unplanned interruptions. Accordingly, TransGrid endeavours to provide supply availability values within a band of 99.0% to 99.2%.

The following graph shows TransGrid's Circuit Availability performance since 1994:

Circuit Availablity



3.3.3 Forced and Emergency Outages

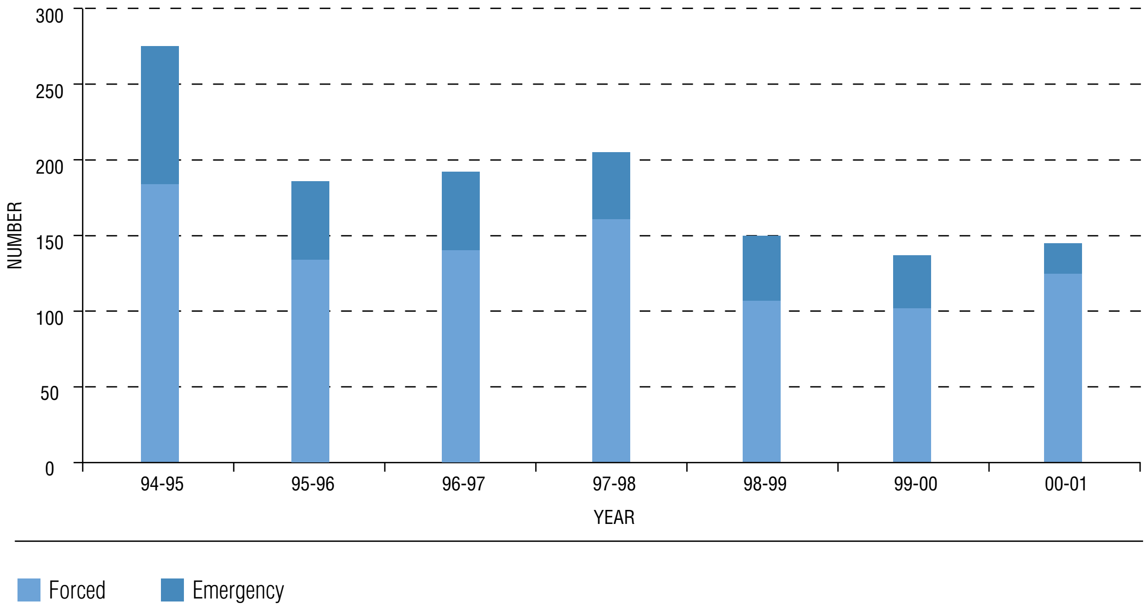
This service standard is a measure of the number of unplanned outages occurring on the transmission network. Forced outages are those outages that automatically take the equipment out of service and includes incidents such as storms, bushfires and equipment failure. Emergency outages are outages taken on equipment due to condition monitoring or visual inspections identifying that urgent remedial action is required.

Year on year performance of this indicator can very much be influenced by environmental factors.

The trend shows that despite an increase in the average age of the assets there is a continual decrease in the total number of emergency outages.

The increase in forced outages from 1999-2000 to 2000-2001 was mainly due to overhead mains related issues that involved a variety of causes including lightning strikes, bushfires, vegetation contact and some unknown factors.

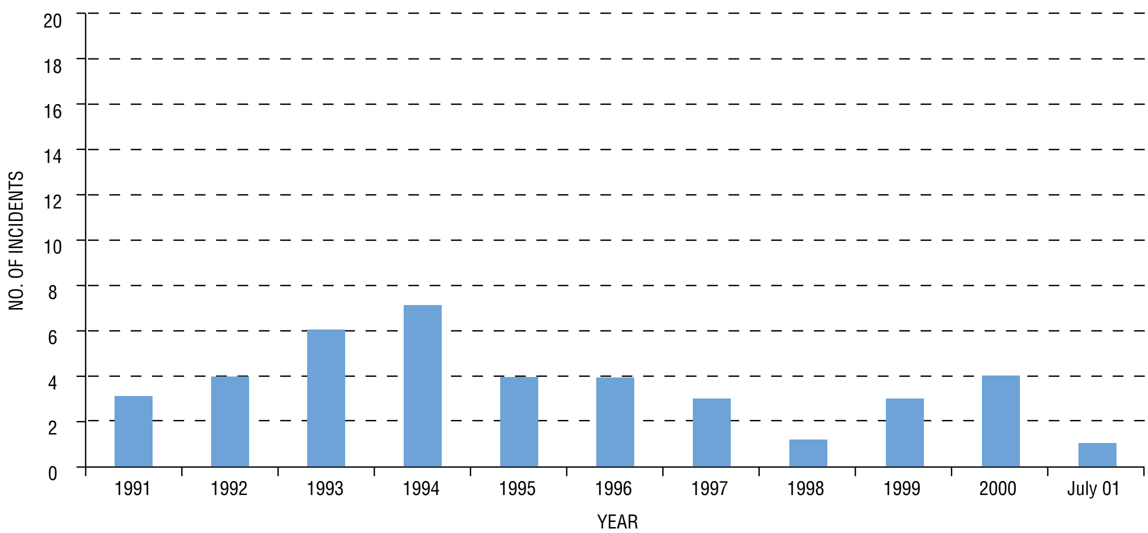
Forced and Emergency Outages



3.3.4 Significant Substation Incidents

These are incidents that occur on the network that have significant impact on safety, environment or supply. As mentioned above in 3.3.1, in the year 1999/ 2000 there were a number of incidents which were non-typical that also impacted upon reliability of supply. A graph of significant substation incidents since 1991 is shown below.

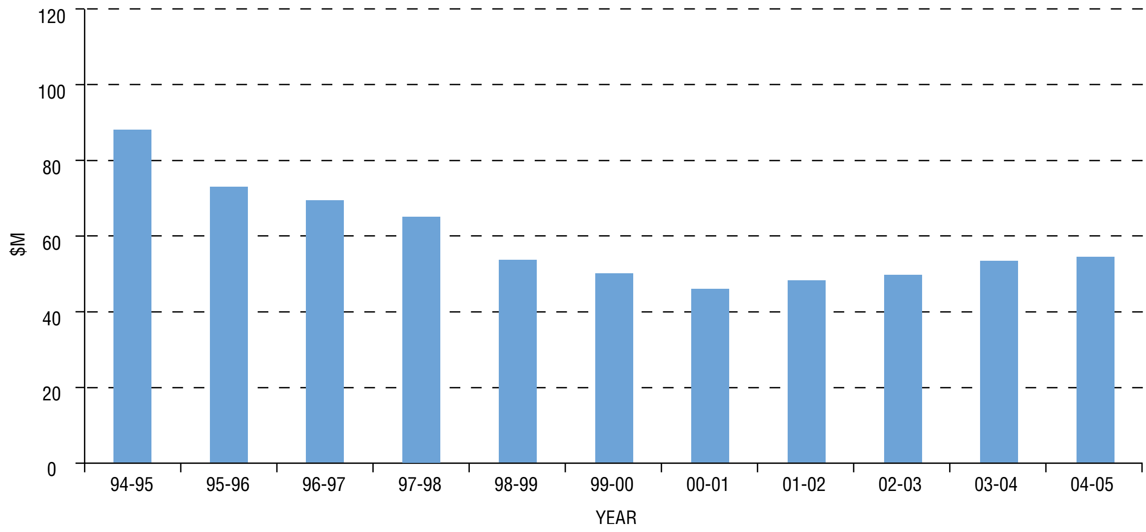
Significant Substation Incidents



3.3.5 Network Maintenance Costs and Asset Replacement Expenditure.

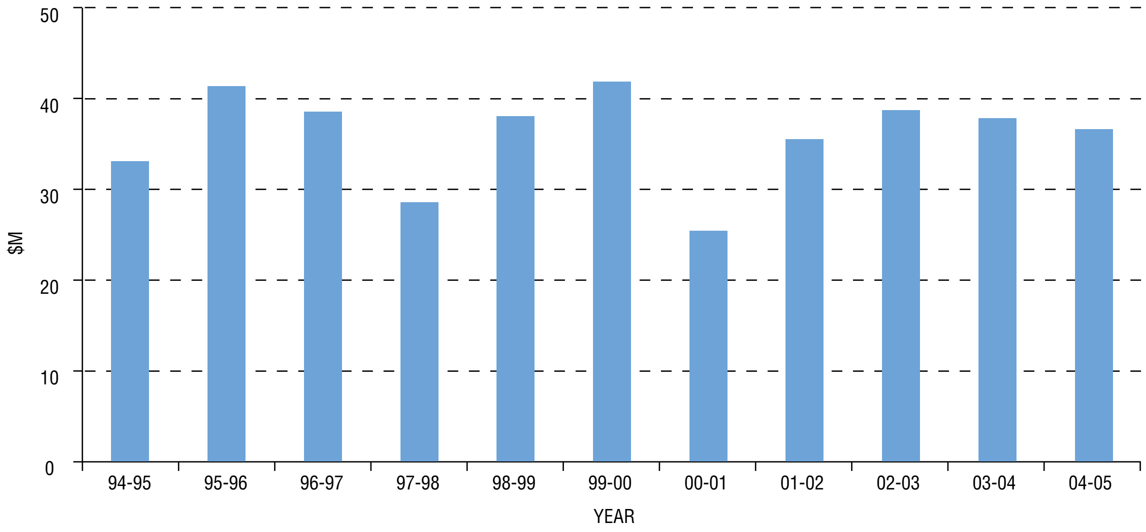
Network maintenance costs have been effectively reduced over the past ten years and more specifically in the last 5 years through the introduction of improved maintenance practices, the replacement of selected ageing plant and adoption of on-line condition monitoring techniques. Throughout the period TransGrid has consistently achieved in excess of 95% of its maintenance plan on a year by year basis. A graph of Network Maintenance Costs and Asset Replacement and Refurbishment Costs since 1994-95 are shown below.

Network Maintenance Costs (in 1999 dollars)



Note: Future estimates beyond 2002 are preliminary and account for anticipated expansion of TransGrid's network by the amount of $1 billion.

Asset Refurbishment and Replacement Costs (in 1999 dollars)



Note: Expenditure for 98/99 and 99/00 includes Y2K related work and an expedited program of current transformer replacement.

Further performance measures relating to quality of supply have been developed or are in the process of being developed and include frequency, voltage and harmonics.

4 Asset Strategies

4 Asset Strategies

4 Asset Strategies

4.1 Capital Investment Strategies

The following is a summary of current and emerging constraints (capacity limitations in TransGrid's transmission network) over an outlook period of 5 years and either committed augmentations (Section 4.1) or indicative network options (Section 4.2) to relieve them. This defines, in broad terms, TransGrid's capital investment strategies for new regulated work over that period. More details are given in TransGrid's Annual Planning Statement for 2001.

It should be emphasized that indicative options are subject to economic analysis in accordance with the National Electricity Code with the ACCC's Regulatory Test being applied to these and other network options and non-network options such as DSM and embedded generation.

4.1.1. Constraints to be Relieved by Committed Augmentations

4.1.1.1. Kempsey – Nambucca – Coffs Harbour 132 kV Transmission Line and Substation

The load growth over recent years in the Coffs Harbour, Sawtell, Nambucca Heads, Macksville, Kempsey, Raleigh and Port Macquarie areas has been relatively high. The existing 132 kV and underlying 66 kV transmission system is not able to support the full load in the area under line outage conditions.

The works that are being constructed to overcome this constraint include reconstruction of the existing Coffs Harbour to Kempsey 66 kV line to a double circuit 132 kV transmission line and the establishment of a new Nambucca 132/66 kV Substation. The line and substation are currently under construction.

4.1.1.2. Development of Supply to the Molong, Manildra, Cumnock and Cudal Areas

The Molong, Manildra, Cumnock and Cudal areas are situated about 30 km North West of Orange and are supplied via a radial 66 kV line from Orange 132/66 kV Substation. In the absence of an augmentation to the area the thermal rating of this line would have been exceeded by summer 2000/2001.

A programme of augmentations has been determined for these areas that includes:

- Establishment by TransGrid of a 132/66 kV Substation near Molong. This was completed in early 2001;
- replacement by Country Energy of its Manildra 66/11 kV Substation by a new 132/11 kV substation by early 2002; and
- construction by TransGrid of a 132 kV line from Molong to Manildra by to match the commissioning of Manildra 132kV Substation.

4.1.1.3. Development of Supply to the Sydney City Central Business District

Supply to the Sydney Central Business District (CBD) and inner suburbs is currently provided by EnergyAustralia's 132kV network linking TransGrid's 330/132kV Substations at Beaconsfield, Sydney South (Picnic Point), and Sydney North (Dural). Beaconsfield 330/132kV Substation is supplied via a single 330kV cable from Sydney South.

Failure of the Sydney South - Beaconsfield 330kV cable and any one of thirty other critical circuits or transformers in the Sydney area would mean that the peak summer load could not be supplied in summer 2003/04 and subsequently.

A programme of augmentations has been determined that includes construction of a 330kV cable from Sydney South to a new 330/132kV Substation at Haymarket. This work is scheduled for completion by October 2003.

4.1.1.4. Canberra 330/132 kV Substation Fourth Transformer

Canberra 330/132 kV Substation has two 400 MVA transformers and one 375 MVA transformer. The capacity of these transformers is expected to be exceeded in winter 2002 based on the expected growth of the Canberra load.

A fourth 330/132 kV transformer will be installed and commissioned at Canberra by winter 2002.

4.1.1.5. Koolkhan 132/66 kV Substation Transformer Replacement

The peak load at Koolkhan Substation is expected to exceed the firm rating of the 30 MVA transformers at the site by winter 2002.

Work has commenced on the replacement of the existing 30 MVA units with 60 MVA units and is expected to be completed by April 2002.

4.1.1.6. Tumut 132/66 kV Substation Transformer Replacement

Tumut 132/66 kV Substation has two 30 MVA transformers. The capacity of these transformers is expected to be exceeded by winter 2002.

Work has commenced on the replacement of the existing 30 MVA units with 60 MVA units and is expected to be completed by April 2002.

4.1.1.7. Queanbeyan 132kV Substation Fourth Transformer

Queanbeyan 132/66 kV Substation has three 30 MVA transformers. The capacity of these transformers is expected to be exceeded by winter 2002.

One of the 30MVA units released as part of the Tumut transformer replacements will be relocated to Queanbeyan as the fourth transformer. This work is expected to be completed by June 2002.

4.1.1.8. Sydney West 330 kV Substation Fifth Transformer

Sydney West substation is equipped with four 375MVA transformers, and prior to summer 2000/2001 it was loaded close to its full capacity. The co-incident maximum demand in western metropolitan area of Sydney increased by 15% during the summer of 2000/2001 when compared to the previous summer, and this increase in demand was substantially driven by an increase in connected air-conditioning load. Based on a conservative demand forecast, the thermal capacity of Sydney West substation is expected to be exceeded during the summer of 2002/2003.

The existing 375MVA transformers may be replaced by 600MVA units by April 2005. However, as an interim measure, a fifth transformer is to be installed by November 2002.

4.1.1.9. Tamworth 330/132 kV Substation Transformer Thermal Rating Limitations

Tamworth 330/132 kV substation has two 150 MVA transformers tail-ended onto 132 kV lines which are directly connected to Tamworth 132/66 kV substation. The capacity of these transformers is expected to be exceeded by winter 2002.

Augmentation:

A third transformer is to be installed along with the establishment of a 132 kV busbar. This work is expected to be completed by June 2002.

4.1.1.10. Albury - ANM 132 kV Transmission Line Thermal Rating Limitation

Based on projected loads in the Albury/Mulwala area, the thermal rating of the Albury - ANM 132 kV transmission line may be exceeded by summer 2001/2 under line outage conditions.

The line conductors will be uprated prior to summer 2001/2.

4.1.2. Emerging Constraints and Indicative Network Options

4.1.2.1. Constraints on Power Transfer to Southwest NSW, Snowy and Victoria

The growth of NSW loads in the Yass - Wagga areas, coupled with a requirement for heavy power transfer from Snowy to Victoria, will exacerbate the potential overloading of a number of lines and transformers in the area.

At this stage an indicative network option that will address the overloading problems and provide for an increase in the power transfer capacity to Snowy and Victoria is the development of a 330 kV line between Yass and Wagga by 2004.

4.1.2.2. Yass 330 kV Substation Equipment Replacement

Yass 330/132 kV Substation is an essential location on the New South Wales main grid. Most of the interconnecting lines to the Snowy system are bused at the substation. The substation was established in 1959 and considerable difficulty is now being experienced in maintaining the substation equipment.

From a system security viewpoint and on an economic basis it is considered necessary to replace the substation 330 kV. The works are programmed for completion by 2004.

4.1.2.3. Limitations in the System Supplying Yass/Canberra and Southwest NSW

Four 330 kV lines presently extend from Sydney and the south coast to the southwest and Snowy areas. The capability of this system to transfer power from Snowy to the north or from the Sydney area into the Southwest area of the State is limited.

The transmission system will need to be supported to supply the growing Southwest area load. Reinforcement by transmission development would also increase the capability for the export of power from NSW to Victoria and possibly from Victoria to NSW.

An indicative network option is the diversion of the Sydney West - Yass 330 kV line into Marulan in 2004.

4.1.2.4. Limitations in the System Supplying the Western Area of New South Wales

The transmission network in the area West of Bathurst has a limited capability. In the near future a number of system limitations will emerge:

- during outages of the Mount Piper - Wellington 330 kV line adequate voltage levels may not be maintained at Wellington, Forbes and Parkes;
- 132kV line thermal ratings may be exceeded during 330kV line outages; and
- the loading on the Wallerawang transformers is approaching the transformer rating during 330 kV line outages.

Options available to address the transmission limitations include:

- installation of additional 330/132 kV transformer capacity in the Western area;
- development of a new 330/132 kV substation in the Icely area;
- 330 kV and 132 kV line developments in the area;
- demand side management;
- development of local generation.

An indicative network option is a staged development as follows:

- 2003/4 Construction of a 330/132 kV substation near Icely
- 2004 Construction of a sector of 300 kV line from Yettolm to Icely
- 2005 Construction of a 330 kV line from Icely to Wellington.

4.1.2.5. Limitations in the System Supplying the Greater Sydney Area

Supply to the greater Sydney area is provided by a number of 330 kV substations interconnected with the state's power stations and power system in the southern area of NSW. Kemps Creek 500/330 kV Substation provides a focal point for the connection of the 330 kV lines which interconnect the Sydney 330 kV substations. It is also the termination point of the 500 kV double circuit line from the central coast power stations. The integrity of Kemps Creek Substation and its 330 kV connections are critical to the supplies to a large portion of the Greater Sydney area load.

The need for reinforcement of supply to this area to meet the growing load arises from the impact of a number of possible main system contingencies. At this stage, pending more detailed planning and subject to continued load growth, it is necessary to make plans for a reinforcement of the network in the area between about 2005 and 2010.

An indicative network option that could be developed in an environmentally acceptable manner is the connection of Kemps Creek to Liverpool 330 kV substation.

4.1.2.6. Liverpool 330 kV Substation Transformer Thermal Rating Limitation

Liverpool 330 kV substation is equipped with two 375MVA transformers with some limited load transfer capability to Sydney West. Due to the higher than expected load growth in the western metropolitan area of Sydney, the ability to transfer any load to Sydney West is no longer possible, and on a conservative load forecast the capacity of this substation could be exceeded by the summer of 2003/2004.

At this stage an indicative network option is to install a third transformer.

4.1.2.7. System Reactive Capability

The Sydney area load is growing and the reactive power requirements in the area have required the installation of large capacitor banks at various TransGrid substations in the area annually for many years. There is an emerging need for the installation of dynamic reactive support in this area:

An indicative network option is the installation of an SVC in Sydney during 2002.

Ongoing reactive support is also required in other parts of the main transmission system with requirements being determined with short lead times.

4.1.2.8. Limitations in the System Supplying the Central Coast

The majority of the Central Coast load area is supplied from Tuggerah 330/132 kV substation and the recently commissioned Munmorah 330/132 kV substation. Tuggerah 330 kV substation is equipped with a single 375MVA transformer and supplied by a single 330 kV connection through a tee connection to the Munmorah to Sydney North 330 kV line.

The preferred network option for duplicating the 330 kV supply to Tuggerah involves rebuilding a section of the existing 330 kV line from the tee point at Sterland to Tuggerah.

4.1.2.9. Limitations in the System Supplying the Greater Newcastle and Lower North Coast

Load in the Newcastle area comprises the metropolitan area load and the smelter loads at Alcan and Tomago. The need for augmentation to the supply to the area will be driven by the following factors:

- possible development of additional aluminium smelting load at Tomago;
- development of loads in the Tomago area;
- development of loads on Kooragang Island; and
- general load growth in the area.

An indicative network option is the installation of two 330/132 kV transformers and associated switchgear at Waratah West by summer 2004/5.

4.1.2.10. Limitations in the System Supplying the Lismore Area

The Lismore area is supplied by a single 330 kV line from Armidale and a supporting 132 kV system.

Over recent years the capability of this system to supply the Lismore and far north coast area load has been limited by voltage control constraints to less than the prevailing peak demand following an outage of the Armidale - Lismore 330 kV line.

System security has been improved by the installation of the Lismore SVC and capacitor banks at Armidale and Coffs Harbour in 1999. Initially these improvements will enable the full load of the area to be supplied following an outage of the Armidale - Lismore 330 kV line.

However, the load growth in the area is relatively high and the full area load will not be covered beyond about 2003 to 2005 when 132 kV line thermal limits will be reached following an outage of the 330 kV line.

Indicative network options both involve the development of an additional 330 kV line to the area by 2004.

4.1.2.11. Limitations in the System Supplying the Coffs Harbour and Nambucca Coastal Areas

The load growth over recent years in the Coffs Harbour, Sawtell, Nambucca Heads, Macksville, Kempsey, Raleigh and Port Macquarie coastal areas has been relatively high. The load growth in the area will result in the capability of the 132 kV transmission system and the rating of the Armidale 330/132 kV transformers being exceeded by winter 2003.

An indicative network augmentation option is the development of a 330 /132 kV substation at Coffs Harbour. This reinforces supply to the area and enables a reduction in system losses. It also provides a reinforcement of supply to the mid north coast area via the new 132 kV line to Kempsey.

4.1.2.12. Limitations in the System Supplying the Taree, Port Macquarie and Kempsey Areas

The mid north coast of NSW comprises the load areas supplied from Kempsey, Port Macquarie and Taree substations. The load in this area is growing steadily.

By the winter of 2003, in the event of an outage of any one of the Armidale - Kempsey, Kempsey - Port Macquarie, Tomago - Taree, or Kurri - Stroud 132 kV lines, the voltage levels at Port Macquarie and Taree connection points would fall below acceptable levels

This and other limitations are only fully overcome by relatively substantial network support in the area, involving new line development. Options for this development include the following.

- 330 kV or 132 kV line from Armidale to Kempsey
- Conversion of the 66 kV circuit of the Kempsey - Nambucca - Coffs Harbour line to 132 kV operation
- 132 kV line from Kempsey to Port Macquarie
- Tomago - Taree 330 kV line
- Waratah West - Stroud 132 kV line

4.1.2.13. Limitations in the System Supplying the Glen Innes and Inverell Areas

Load growth will result in the capacity of the transmission system supplying the Inverell and Glen Innes areas being exceeded by the mid 2000's.

An indicative network option is the development of a new 132 kV transmission line between Glen Innes and Inverell by 2006.

4.1.2.14. Limitations in the System Supplying the Gunnedah, Narrabri and Moree Areas

The transmission system supplying the Gunnedah, Narrabri and Moree areas has limited thermal capacity. The system is also limited by reactive power constraints. There are also constraints on planned maintenance activities on the existing 132 kV transmission system in the Northwest region of the State. Reinforcement is required to improve the reliability and quality of supply to the area.

An indicative network option is the construction of a 132 kV line from Tamworth to Gunnedah by 2007.

4.1.2.15. Limitations in the System Supplying the Parkes, Forbes and Cowra Areas

The Parkes, Forbes and Cowra areas are supplied via a number of 132 kV lines, which interconnect Wellington and Yass 330/132 kV substations. A number of mining and mineral extraction and processing developments have been proposed for this area. Based on the current load forecast adequate voltage levels may not be able to be maintained in these areas during an outage of the Wellington to Parkes 132 kV line.

An indicative network option is the construction of a 132 kV line from Manildra to Parkes by about 2004.

4.1.2.16. Wagga 132/66 kV Substation Transformer Rating Limitations

Based on the current load forecast, the firm transformer capacity of this substation will be exceeded in the summer of 2003/2004.

At this stage an indicative network option is the development of a new substation at Morven in conjunction with Country Energy by summer 2003/2004.

4.1.2.17. Limitations in Line Ratings from Wagga 330/132 kV Substation to Wagga 132/66 kV Substation

Wagga 132/66 kV Substation is supplied over two 132 kV lines from Wagga 330/132 kV Substation and a long 132 kV line from Yass. Based on the current load forecast, the 132 kV transmission line capacity from Wagga 330/132 kV Substation to Wagga 132/66 kV Substation will be exceeded in summer 2004/5.

An indicative network option to overcome this limitation is the establishment of a new 132 kV switching station in the North Wagga area.

These works are estimated to cost $3.5 million. They would be required to be completed by 2004/5 or earlier depending on the impact of the development of a new 330 kV line to Wagga.

4.1.2.18. South Australia - New South Wales interconnector (SNI)

SNI is a proposal by TransGrid to directly interconnect the National Electricity Market regions of New South Wales and South Australia. The proposal has been developed in response to an acknowledged need for such a connection in the NEM. TransGrid is in the process of having SNI assessed by NEMMCO as a regulated interconnector.

The project consists of a new 275 kV line from Buronga in New South Wales to Robertstown in south Australia, uprating the Darlington Point - Buronga line to 275 kV operation and other ancillary works. The total cost of the works is estimated to be $110 Million and is proposed to be in service by the summer of 2003/4.

4.1.2.19. Uprate Bayswater - Mount Piper - Marulan lines to 500kV

Increasing loads in the Newcastle area and increased generation in the Hunter Valley and from northern New South Wales is likely to be constrained by transmission capacity south from Liddell/Bayswater. Uprating the Bayswater - Mount Piper - Marulan lines to operate at 500kV provides increased capacity in that part of the network.

4.1.3. Summary of Capital Investment Strategy

The table on the following page summarises the above capital investment strategy

Capital Investment Strategy Summary - Committed Augmentations

Item	Constraint	Committed Augmentation	To be Completed By
4.1.1.1	Kempsey – Nambucca – Coffs Harbour T/Line & Substation	New 132 Sub and line	2001
4.1.1.2	Supply to Molong, Manildra, Cumnock & Cudal	New 132 Sub and line	2002
4.1.1.3	Supply to Sydney CBD	New 330 kV Cable	2003
4.1.1.4	Canberra 330/132 kV Substation Fourth Transformer	New Transformer	2002
4.1.1.5	Koolkhan 132/66 kV Substation Transformer Replacement	2 New Transformers	2002
4.1.1.6	Tumut 132/66 kV Substation Transformer Replacement	2 New Transformers	2002
4.1.1.7	Queanbeyan 132kV Substation Fourth Transformer	New Transformer	2002
4.1.1.8	Sydney West 330 kV Substation Fifth Transformer	New Transformer	2002
4.1.1.9	Tamworth 330/132 kV Substation Third Transformer	New Transformer	2002
4.1.1.10	Albury - ANM 132 kV Transmission Line Uprate	Uprate Conductors	2002

Capital Investment Strategy Summary - Emerging Constraints

Item	Constraint	Indicative Augmentation	Required By	Estimated Cost ($000's)
4.1.2.1	Constraints on Transfer Capability: Snowy to Victoria	New 330 kV development	2004	60,000
4.1.2.2	Yass 330 kV Substation Equipment Replacement	Equipment Replacement	2004	30,000
4.1.2.3	Limitations in the System Supplying Yass/Canberra	330 kV line works	2004	20,000
4.1.2.4	Limitations in the System Supplying the Western area	New 330 kV development	2005	65,000
4.1.2.5	Limitations in the System Supplying Greater Sydney area	Reconstruct 330 kV Line	2005	35,000
4.1.2.6	Liverpool Transformer Limitations	New Transformer	2004	5,000
4.1.2.7	System Reactive Capability	New SVC in Sydney	2002	20,000
4.1.2.8	Limitations in the System Supplying the Central Coast	330 kV line works	2004	5,000
4.1.2.9	Limitations in the System Supplying Greater Newcastle	2 New Transformers	2005	12,000
4.1.2.10	Limitations in the System Supplying the Lismore area	New 330 kV development	2004	100,000
4.1.2.11	Limitations in the System Supplying Coffs Hrbr, area	New 330 Sub	2004	10,000
4.1.2.12	Limitations in the System Supplying Taree, area	New 132 kV Lines	2004	30,000
4.1.2.13	Limitations in the System Supplying Glen Innes area	New 132 kV Line	2006	8,000
4.1.2.14	Limitations in the System Supplying Gunnedah area	New 132 kV Line	2007	7,000
4.1.2.15	Limitations in the System Supplying Parkes area	New 132 kV Line	2004	6,000
4.1.2.16	Wagga 132/66 kV Substation Transformer Limitations	New 132 kV Sub	2004	3,500
4.1.2.17	Limitations in Line Ratings in Wagga area	New 132 kV Sub	2005	3,500
4.1.2.18	South Australia - New South Wales Interconnector (SNI)	New NSW - SA 275 kV line	2003	110,000
4.1.2.19	Bayswater/Mount Piper/ Marulan	Uprate to 500kV	2007/8	80,000

4.2 Asset Maintenance and Operating Strategies

4.2.1 Maintenance Strategies

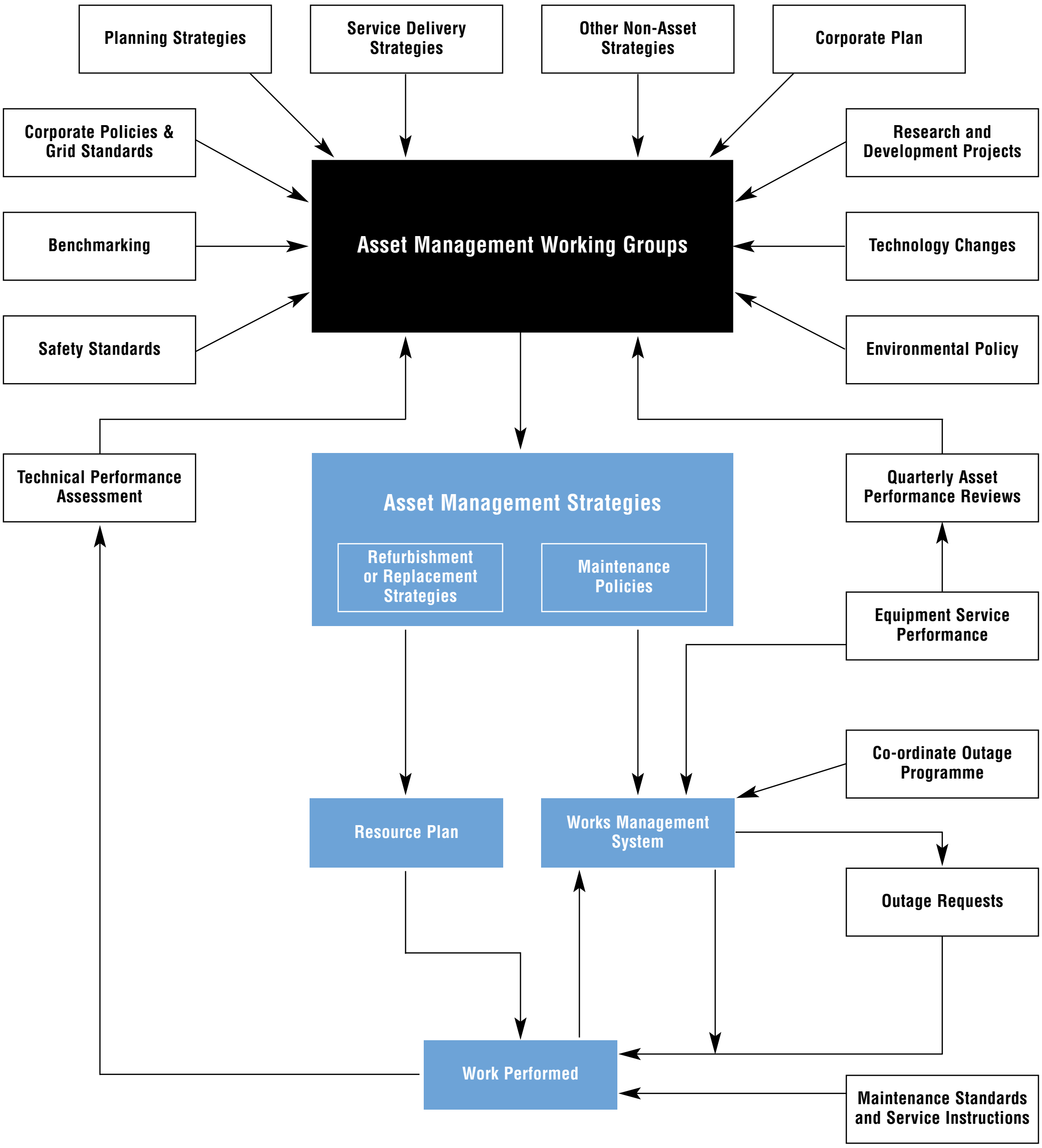
Principles of TransGrid's Asset Management Strategy Processes

TransGrid uses well-developed and documented processes to ensure that its existing assets are effectively and efficiently managed.

A simple overview of the Asset Management Strategy Process is shown below in Figure 2.

The quality of TransGrid's asset management process was recognised by the receipt of a National Engineering Excellence Award in 1997.

Figure 2 - TransGrid's Asset Management Strategy Processes



Elements of TransGrid's Asset Maintenance Strategy Process

1. Structure

The development and updating of both the Asset Management Strategies and the Maintenance Policies is carried out by Working Groups made up of a cross-section of maintenance, design and asset management staff. The Working Groups meet regularly to discuss issues and resolve problems identified.

2. Asset Management Policy

The Key Corporate Policy is the Asset Management Policy which is a high level document describing the principles of asset management that apply to all of TransGrid's assets.

The work identified as necessary is categorised as either Capital or Operating for budgetary purposes. The operating work is further split into two categories.

(i) Maintenance work - which is routine and repetitive in nature and specified by the relevant maintenance policy.

(ii) Major Operating Projects - these are non-repetitive and require the investment of significant resources on a one off basis. Refurbishment work and some replacements fall into this category. The performance issues and proposed solutions are detailed in the relevant Asset Management Strategy.

3. Asset Management Strategies

Asset Management Strategies are prepared for each of the following functional areas:

- Substations
- Underground cables
- Transmission lines
- Protection schemes
- Metering installations
- Communications & SCADA

These Strategies are updated annually and detail both the short and medium term strategies used to address issues beyond the scope of routine maintenance activities.

Information relating to the performance of the assets, including maintenance history and defect history are used in the review process to determine if any action is required on a specific issue.

Condition monitoring information is used extensively to identify equipment approaching the end of its useful service life thus allowing for planned replacement or refurbishment programs to be implemented.

4. Asset Maintenance Policies

Maintenance Policies for each of the functional areas are also reviewed and updated annually. As with the Asset Management Strategies extensive use is made of maintenance history, defect history, benchmarking and condition monitoring data.

The maintenance policies are implemented through a computerised Works Management System (WMS) that schedules, initiates and records both routine and non-routine maintenance and defect repairs.

TransGrid has a policy of minimal intrusive maintenance, preferring instead to carry out diagnostic testing to determine if a need exists for any further work. Maintenance is generally targeted according to the following criteria:

- Significance of a failure of the item
- Past reliability and service performance
- Physical location/environmental factors
- Operating history

5. Maintenance Planning

Asset maintenance plans are detailed in a Maintenance Policy and Asset Strategy for each asset category. Each Maintenance Policy describes the routine maintenance frequency and extent of routine maintenance for each item of plant. The Asset Strategies take a broader perspective and detail refurbishment / replacement / repair strategies for particular types, makes or categories of equipment.

In planning any routine or non routine work (including new project or construction work), that involves a system outage a significant effort is made to package as much work as possible to minimise the number and duration of any outages as these may impact on the Availability of the network.

6. Risk Management

In addition to developing, enhancing and maintaining its transmission network, TransGrid ensures that risks to the system are understood and quantified.

Both the Maintenance Polices and Asset Strategies are reviewed using risk management principles, considering the criticality and exposure associated with a particular course of action that could materially affect the network and the quality, availability and reliability of supply to our customers.

7. Contingency Planning

TransGrid works closely with the civil defence organisations (police, ambulance and fire brigade) for natural disaster events and is suitably prepared to manage operations and restorations of supplies. However customer expectations for the security and reliability of electricity supplies is high as regional and state economies are very dependent on achievement of these expectations.

Contingency planning is an integral part of the risk management process and although it is not realistic to plan for all possible events there needs to be a common understanding of the extent of anticipated events and the extent of the contingency planning necessary to cover these events.

A Corporate Emergency Management Plan (CEMP) has been prepared to coordinate the Management measures necessary to ensure that TransGrid is prepared for emergencies which may impact upon reliability of supply, the safety of staff and the public or the environment.

A number of Regional Emergency Response Plans support the Corporate Emergency Management Plan, and to ensure effective operational response to emergencies.

8. Loss of Equipment

The outcome of most risk events will be the temporary or permanent loss of specific network equipment.

TransGrid's asset procurement policy ensures that, for reasons of economy, there is a reasonable degree of commonality across the state. There are a number of unique installations where there is only limited opportunity for direct interchange of spare equipment. In most cases, however, spare equipment can be readily obtained and modified if necessary to effect temporary repairs.

Emergency transmission line structures are held by TransGrid, which can be quickly assembled and erected, in the unlikely event of major line failures. These are held at key sites throughout the state and are suitable for most tower line locations.

A number of spare transformers are held at strategic locations throughout the state. A formal policy exists defining the number of spares of a given type to be held based on the size of the transformer population. Other spares such as circuit breakers, instrument transformers, surge arrestors, protection relays etc. are constantly monitored to ensure optimal levels are held.

9. Asset Performance Reviews

The ultimate measure of whether the asset management process is achieving its stated goals is determined by the performance of the transmission network. Consequently within TransGrid a number of methods are used to objectively measure the outcomes of the process and these are used to indicate whether:

- Policies are appropriate
- Policies are being applied
- Equipment performance is satisfactory
- Performance/costs are comparable

The actual methods used to perform this function include the following:

10. Technical Performance Assessments

Technical Performance Assessment are carried out on each Region within TransGrid on a yearly basis and the assessment formally audits the technical performance of the maintenance groups. The assessment is conducted over a number of days and checks processes, documentation and the physical condition of the assets.

Independent auditors with specialist knowledge of the functional area conduct the assessments. A formal report detailing non-conformances, observations and improvement opportunities is prepared and follow up reports required to ensure that any issues identified are addressed.

11. Quarterly Asset Performance Reviews

Once each quarter, design, maintenance, operating and asset management staff are brought together to specifically review the performance of the network assets during the previous three months.

All forced and emergency outages during the period are reviewed in detail and where necessary further action initiated. The group also reviews the long-term outage/reliability trends to determine issues requiring further investigation.

Issues identified by either a Technical Performance Assessment or the Quarterly Asset Performance Review are passed on to the relevant Working Group for inclusion in their policy/strategy deliberations.

12. ISO 9001 Quality Audits and ISO 14001 Environmental Audits

Despite the large geographical distances between Regions and their assets, TransGrid ensures confidence in the effective application of identical policies and practices across the network through maintaining its certification to AS/NZS ISO9001 for Quality Management and AS/NZS ISO14001 for Environmental Management Systems.

To achieve the maintenance of both these certifications, TransGrid follows a 3 year cycle consisting of 6 monthly audits and a 3 yearly certification assessment by an appropriate Certification Body.

13. Electricity (Safety Plan) Regulation Audits

The health and safety of all TransGrid staff, the general public, contractors and visitors to TransGrid's sites is of prime importance to TransGrid's business. Occupational health and safety are essential to the successful performance of every task.

In accordance with the Electricity Supply (Safety Plans) Regulation 1997, under the Electricity Act 1995, TransGrid has prepared a Safety and Operating Plan which brings together all the documents pertaining to health and safety, maintenance and training within the organisation.

This Safety and Operating Plan is audited annually by an independent external Auditor to ensure compliance with the Regulation.

14. External Benchmarking

Since 1995 TransGrid has been a participant in the International Transmission Operating and Maintenance Study (ITOMS) that benchmarks maintenance activities performed by high voltage transmission utilities. The study involves some nineteen transmission organisations from Australia, New Zealand, USA, Europe, Britain and Scandinavia.

The ITOMS results are used by TransGrid as a basis to carry out a detailed review of the various maintenance policies and strategies being adopted by not only overseas utilities but also most of the Australian utilities. The results from ITOMS99 confirmed the success of TransGrid's revised policies and provided data for further policy revisions in other maintenance areas.

The impact of these policy revisions and changes in work practices will be assessed in the forthcoming 2001 ITOMS study, which will review 2000-2001 data.

15. Internal Benchmarking

TransGrid has developed an Internal Benchmarking Plan which provides a framework of internal benchmarking processes for network maintenance activities. Implementing this Plan has focused effort and guided maintenance and asset management practices towards improving TransGrid's overall maintenance performance and performance in specific maintenance functions.

By internally benchmarking its three Regions, utilising a format similar to ITOMS, TransGrid is able to identify those locations that impact on TransGrid's combined performance in specific maintenance activities providing a driver to improve that local performance.

Internal benchmarking reports are prepared bi-annually.

16. Asset Management Research and Development

Current and recent R&D activities in the field of Asset Management include:

- Remote Condition Monitoring of Network Assets
- Installation of Remote Video Cameras in Substations
- Power Transformer Thermal Imaging Monitor
- On-Line Circuit Breaker Monitor
- Quality of Supply Measurements
- On-Line Current Transformer and Bushing Monitoring Systems
- On-Line Gas in Oil Monitoring for Power Transformers
- Return Voltage Measurement (RVM) for predicting remaining life of aged power transformers.
- Partial Discharge Monitors on Power Transformers
- Remote Monitoring of Communication Facilities

4.2.2 Operation Strategies

1. Operations policies

Policies are developed and reviewed specifying the principles for operating TransGrid's assets so as to optimise their use while ensuring equipment and personal safety and security of supply. Reviews are based on statistical performance data, comparison of practices of other utilities and the introduction of new technologies. The policies are documented in operating manuals which are used by TransGrid operating staff, network staff and by NEMMCO.

2. Network planning and adequacy assessment

Long-term network augmentation plans are reviewed and improvements are proposed to the network planning group based on operational experience with the existing network.

The adequacy of TransGrid's network in the medium term is checked through computer studies to identify if there are any shortcomings in the planned network augmentations or in the timing of projects. Where potential problems are identified, corrective action is coordinated with network planning and projects groups to ensure provision of the necessary transmission assets on time. Where a delay is unavoidable, interim solutions are developed such as special operational strategies and automatic control schemes to manage the risk of supply interruption.

3. Network capability determination

The capabilities of all transmission elements are determined by System Operations for operational use by TransGrid and by NEMMCO to ensure the safety of TransGrid's assets as well as ensuring secure network operation, reliability of supply and safety to staff and public.

Operating constraints which apply to the transfer of power through TransGrid's network are determined for transmission outage conditions. This is carried out to determine optimal arrangements for planned maintenance or for reconstruction work, and to advise Market Participants of potential impacts of this work on their business processes.

4. Operating manuals

A library of operating manuals is constantly maintained up to date using Quality System principles. The manuals specify TransGrid's operating policies, operating procedures, transmission plant capabilities, network operating arrangements, operating strategies, and operating principles of automatic control systems. These form the basis for operation of the NSW transmission network by TransGrid operating staff and by NEMMCO.

Courses and presentations are given to relevant staff to maintain competency in and provide familiarisation with operational procedures and requirements.

5. Operating graphics

A system of operational single line diagrams is maintained to show all network high voltage equipment and relevant associated low voltage apparatus. Diagrams are instrumental in the operational management of the network and are prepared in differing formats for use by operators and network personnel and for SCADA displays.

6. Network operational management

Operating staff are maintained on duty around the clock seven days a week to monitor network conditions and the occurrence of natural hazards, and to manage abnormal situations. Safe working conditions are arranged for maintenance by TransGrid and other organisations by the preparation, checking and implementation of approved switching procedures. Liaison is maintained on and off shift with NEMMCO and other organisations to ensure adequate coordination of equipment outages and appropriate advice to market participants.

Operations staff are responsible for implementing voltage control on the NSW network. This is done as the agent for NEMMCO, which has the charter to ensure the National Electricity Code requirements for voltage control are carried out.

7. System restart strategy

The main strategy for restoration of the NSW system following a system blackout is developed and regularly updated based on technical considerations and on restoration priorities. The main aims are to optimise the speed of restoration and to minimise risks to the community and to critical industries from prolonged interruption to supplies. An assessment is made of the system restart ancillary services which have been contracted by NEMMCO for this purpose. Training of TransGrid, NEMMCO and general market participants is carried out on a regular basis to ensure familiarity with restoration requirements and restart principles.

8. Network performance assessment

The operational performance of TransGrid's network is monitored and data collected and analysed in order to identify possible improvements in operating instructions or in operator performance, or shortcomings in the network or its operational facilities. Recommendations for system augmentation are prepared when network performance is below adequate operational standards.

System incidents are studied in detail to identify any incorrect performance of plant and possible improvements in operator response. A database of planned and forced outage details is maintained in order to provide network performance statistics for policy reviews in planning, operation and maintenance and for benchmarking against other utilities

9. Operating facilities

Operating facilities for the supervision and remote control of TransGrid's network are regularly reviewed and new requirements identified to ensure that adequate means are available for optimal utilisation of the transmission assets, both under normal and emergency conditions. Regular operational testing of facilities is carried out to ensure continued service availability.

Facilities to improve the efficiency of operational processes are investigated, specified, developed and commissioned when appropriate.

10. Emergency control systems

Specifications are developed for automatic control schemes that will operate during power system emergencies so as to maintain a viable grid and minimise the effects of supply disruptions in the event of non-credible contingencies. These schemes are coordinated where appropriate with network development plans.

11. Operational outage planning and coordination

Plans for outages of transmission assets for maintenance or for reconstruction are examined to determine the impact on network operation, reliability of supply and the extent of possible constraints imposed on the market. This information is provided to affected market participants and is used to facilitate coordination of work by TransGrid's maintenance and project groups and staff of other organisations.

Outage schedules for all work on TransGrid equipment and that of other organisations connected to TransGrid assets are prepared for up to 24 months ahead and refined as necessary to suit changing network conditions and customer requirements while maintaining security and reliability of supply. Details of outages that might have an impact on the operation of the National Electricity Market are submitted to NEMMCO for additional assessment and final approval.

Emergency operational procedures are prepared in advance to ensure effective response in abnormal conditions that might arise from foreseeable contingencies. Procedures are also prepared to enable effective commissioning of new plant, including testing in situ by energising from the main system when required.

4.3 Specific Asset Profiles & Strategies

4.3.1 Asset Profiles

Introduction

This section details some technical data of the numbers and age profiles of the existing assets within TransGrid's network as at 30 June 2001.

The particular assets identified include the following:

- Substations
- Transmission Lines
- Underground Cables
- Protection Schemes
- Metering Installations
- Communications and SCADA

1. Substations

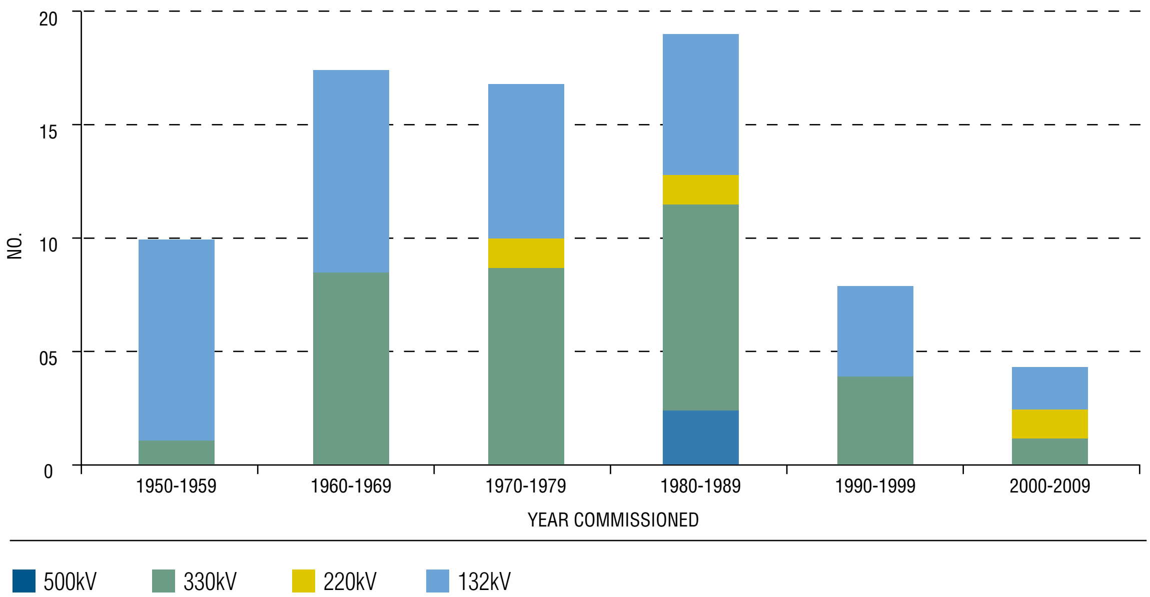
Introduction

TransGrid has a total of 76 substations and switching stations within its network ranging in voltage from 132kV, 220kV, 330kV to 500kV. Their locations vary from coastal to rural, sub-tropical to dry-desert, sea level to high altitude, corrosive locations to stable atmospheres.

Each substation or switching station may comprise high voltage circuit breakers, power transformers, instrument transformers, synchronous condensers, reactors, static var compensators, capacitor banks, control and protection schemes, property and buildings, switchyard structures and hardware, buffer zones, and a multitude of other associated power supplies, cabling and ancillary equipment.

As shown from the age profiles below, approximately one third of substations and switching stations were commissioned before 1970, with the oldest being Burrinjuck commissioned in 1950 and the most recent Balranald and Molong in 2001.

Substation Age Profile

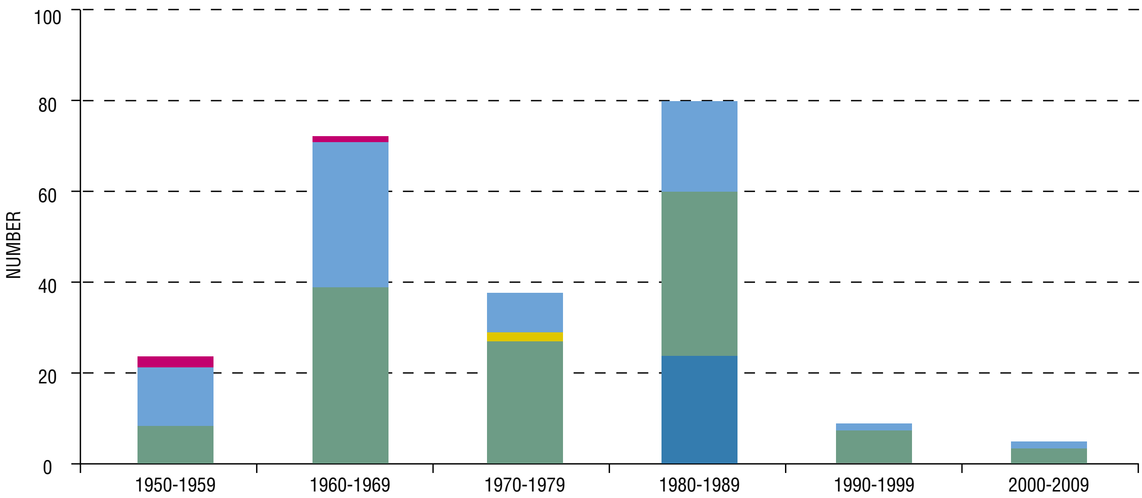


Power Transformers

TransGrid's power transformer population comprises of 203 individual units and of these 56% are rated above 100MVA with a primary voltage of 132kV or higher. Also 38% of this population comprises single-phase units and 92% have on-load tapchangers.

The power transformer age profile shown below indicates that 46% were commissioned before 1970, and some of the oldest units were manufactured pre 1952.

Transformer Age Profile



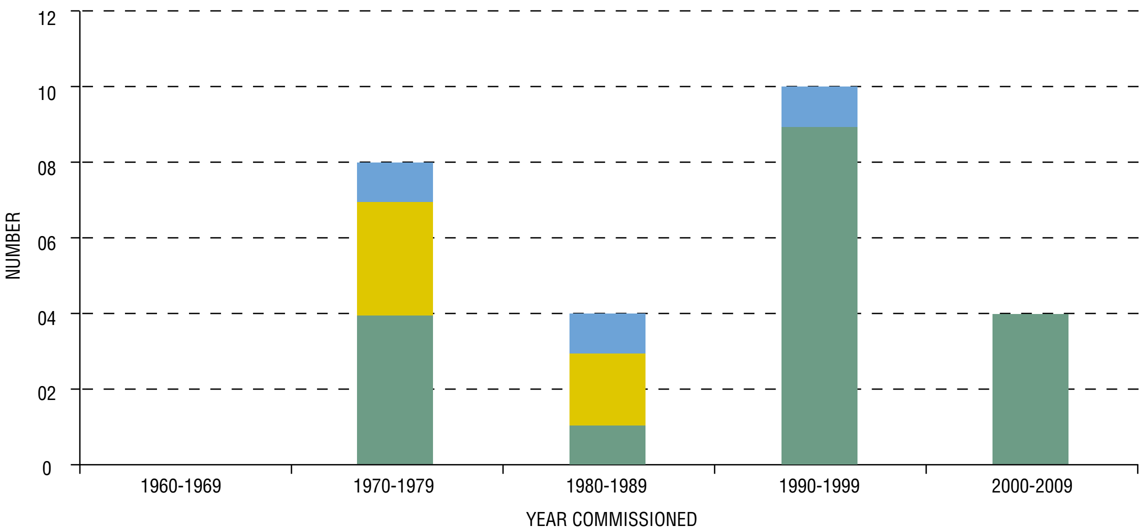
500kV 330kV 220kV 132kV 66kV

Oil Filled Reactors

TransGrid's oil filled reactor population comprises 26 individual units and these include both shunt and series reactor types, 3 at 132kV, 5 at 220kV and 18 at 330kV. Also 33% of this population comprises single-phase units while the remaining are three-phase units.

The age profile shown below indicates that 33% of the installed units were commissioned before 1980 and some of the oldest units were manufactured in 1970.

Oil Filled Reactors Age Profile

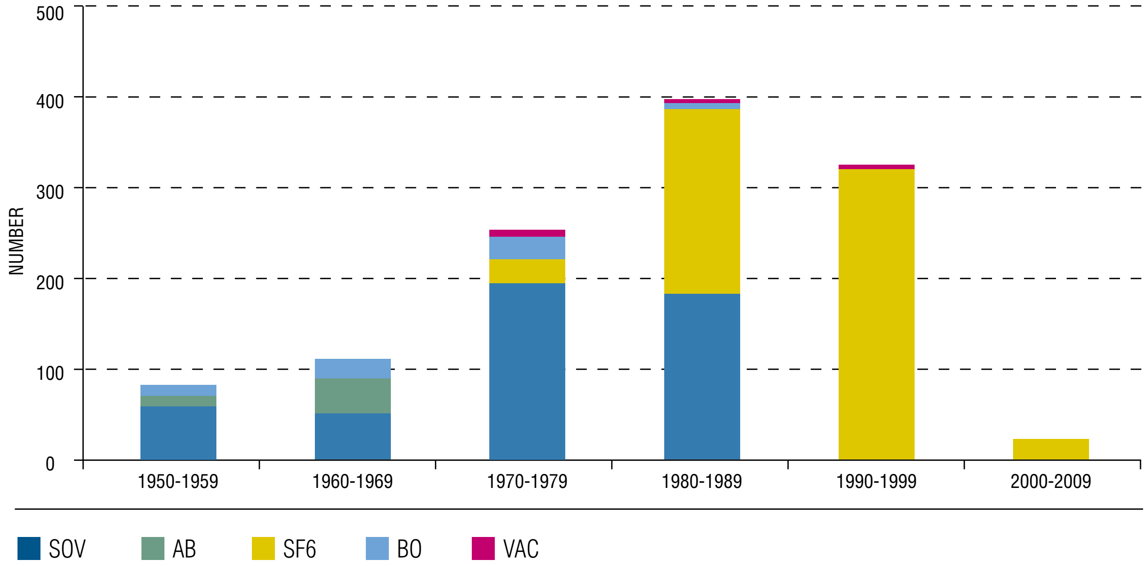


330kV 220kV 132kV

Circuit Breakers

TransGrid's circuit breaker population comprises 1226 units in the voltage range from 11kV to 500kV. The types of circuit breakers used include Air Blast (AB), Bulk Oil (BO), Small Oil Volume (SOV), Vacuum and SF6.

Circuit Breaker Age Profile



All recent circuit breaker purchases at 132kV and above are of the SF6 type with a preference for spring operating mechanism. The type and age profiles given above reflect the various numbers and types of circuit breakers installed on the network as at June 2001.

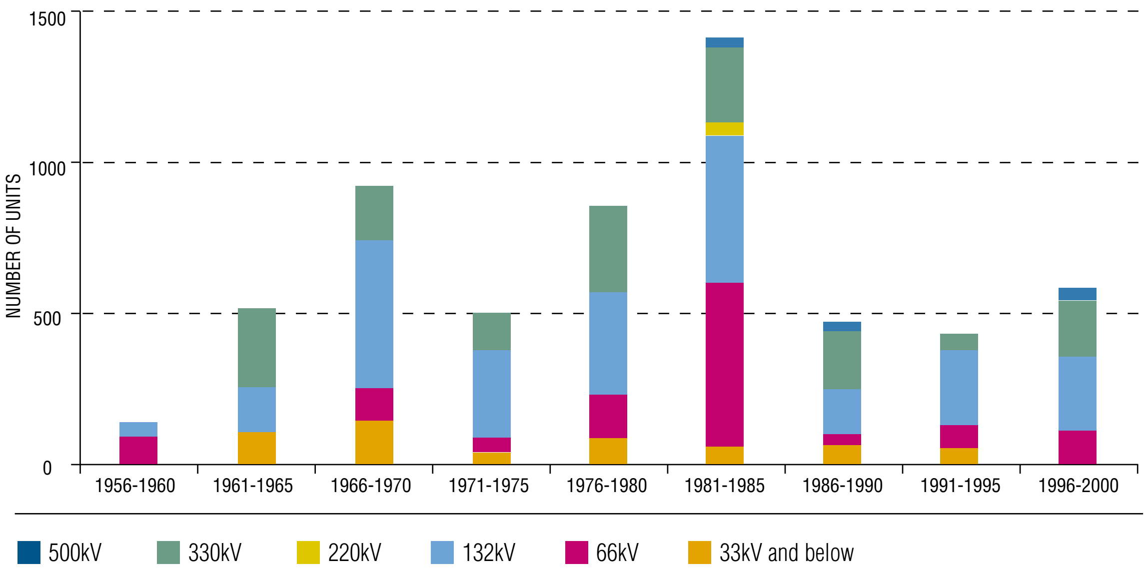
Instrument Transformers

TransGrid manages a total instrument transformer population of approximately 5750 units ranging in voltage from 11kV to 500kV, comprising:

- Current Transformers (approximately 66.5% of population) ,
- 670 Magnetic Voltage Transformers (approximately 12% of population) ,
- 1220 Capacitor Voltage Transformers (approximately 21.5% of population).

The age profile shows that 27% of these units were manufactured before 1970 and some of the oldest units before 1957. All of the above units are of the post freestanding type and any instrument transformers contained within metal clad switchgear, gas insulated switchgear, power transformers and oil filled reactors are not included in the above statistics.

Instrument Transformer Age Profile



Synchronous Condensers

TransGrid has two synchronous condensers each rated at 16kV +/- 75 MVAr located at Sydney South Substation. Both units were commissioned in 1962 and are approching the end of their economic life.

Static Var Compensators

TransGrid has six Static Var Compensators (SVCs) , two at Broken Hill substation (each -50 /+25 MVAr) commissioned in 1986, two at Kemps Creek (each –100/+150 MVAr) commissioned in 1990, one at Lismore (-100/+150 MVAr) commissioned in 2000, and one at Armidale (-120/+280 MVAr) also commissioned in 2000.

Gas Insulated Switchgear

TransGrid owns only one Gas Insulated Switchgear (GIS) facility rated at 132kV. It is located at Beaconsfield West substation and was commissioned in 1979.

Shunt Capacitors

TransGrid has a total of 77 shunt capacitor banks in-service within the network with an installed capacity of 3430 MVArs ranging in voltage from 11kV to 330kV. Of this population 54% are rated at 132kV, 60% were manufactured between 1981 and 1985, and 85% have been manufactured and installed since 1980.

The majority of the capacitor units installed are of the internal fuse type but some externally fused units have also been used. All units are PCB free but some (approximately 985MVAr) contain the fluid Dow C4.

Surge Arresters

Surge Arresters are used to protect expensive items of plant such as transformers from failure due to transient voltage surges. There are 1347 arresters installed within TransGrid's system.

Bushings

TransGrid's transformers and reactors contain some 1685 bushings ranging in voltage from 500kV to 11kV. In general the age profile would follow closely that of the transformers and reactors. These indicate that approximately half of the transformer bushings are more than 30 years old and approximately half of the reactor bushings are over 10 years of age.

Control and Alarm Systems

Control and alarm systems within TransGrid's 76 substations and switching stations range widely from composite mechanical relays to systems built using discrete components that use printed circuit cards, composite electronic relays, programmable logic controllers or microprocessor based systems of various configurations. The age profiles of these systems range from the early 1950s to the present modern technology and some sites have a combination of interconnected systems.

Ancillary Equipment

All substation and switching stations also contain ancillary equipment such as disconnectors, earth switches, surge arresters, busbars, batteries and battery chargers, control and protection cabling, security systems, fire protection equipment, air conditioning, light and power.

Substation Property and Buildings

Each of TransGrid's 76 substations and switching stations contain a control room building which may vary in size from a small single level house to a large multi level establishment. These buildings generally contain a relay room, battery room, communication room, amenities room and workshop.

Sites also may contain fencing, roads, drainage systems, landscaping, environmental buffer zones and other services, which need to be kept in good order.

The age profile for these sites is normally the same as the substation and the style and construction methods vary due to the location, environmental issues and the era built.

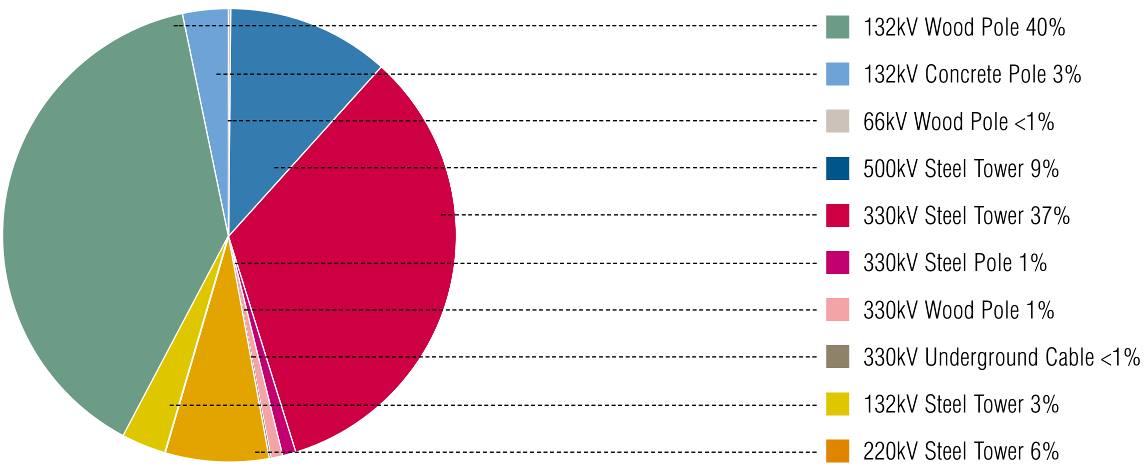
2. Transmission Lines

TransGrid has a total of 10,696 route km and 12,152 circuit km of transmission line with details of constructed and operating voltage given in the following table:

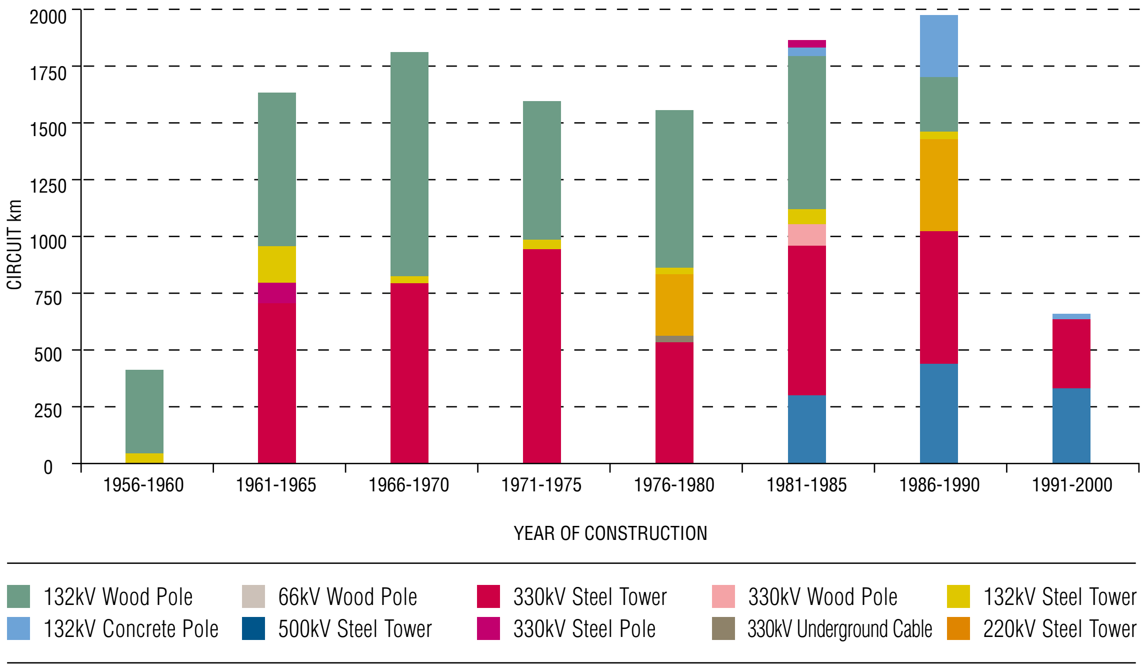
Line Type	Transmission Lines (km) Route	Circuit
500kV in Service at 500kV	143	287
500kV in Service at 330kV	386	771
500kV Not in Service	2	5
Total 500kV	**531**	**1063**
330kV in Service at 330kV	4163	4965
330kV in Service at 132kV	95	144
330kV Not in Service	9	9
Total 330kV	**4267**	**5118**
220kV in Service at 220kV	681	681
Total 220kV	**681**	**681**
132kV in Service at 132kV	5131	5204
132kV in Service at 66kV	4	4
132kV Not in Service	20	20
Total 132kV	**5155**	**5228**
66kV in Service at 66kV	62	62
Total 66kV	**62**	**62**
Totals	**10,696**	**12,152**

These lines are of steel lattice tower, steel pole, concrete pole and wood pole construction. The construction line type and age profiles are shown below:

Transmission Line Type Profile



Transmission Line Age Profile



3. Underground Cables

The primary cable asset owned by TransGrid is the 19.7km 330kV cable 41 between Beaconsfield and Sydney South. This is a paper-oil cable system which was placed into service in 1979. Associated with 41 cable is the pilot cable 160.

TransGrid also has short lengths of cable energised at 132kV, 66kV, 33kV and 11kV which in general, though not exclusively, run within the confines of our substation boundaries.

4. Protection Relays

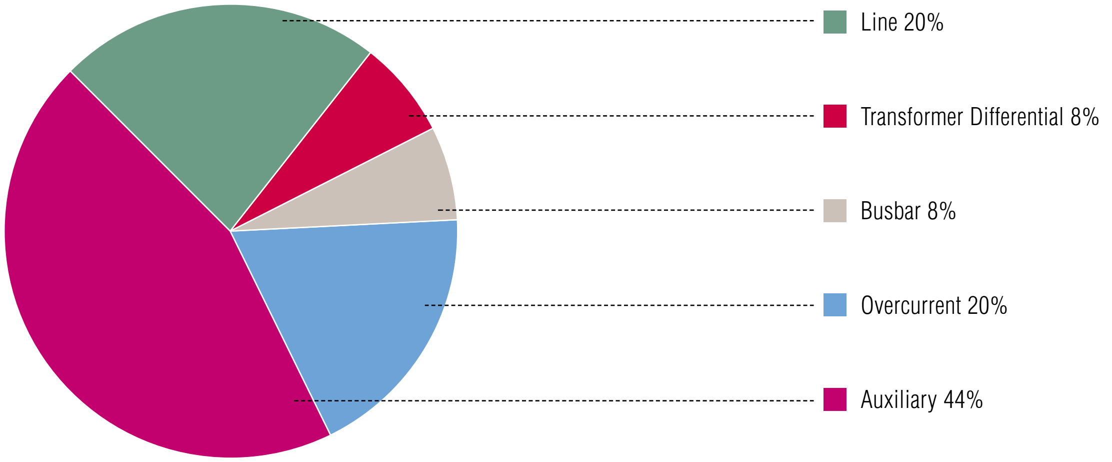
Introduction

Protection equipment at TransGrid sites can be grouped into a number of broad categories. These include :

- Line Protection Relays
- Transformer Differential Relays
- Busbar Protection Relays
- Overcurrent Relays (Instantaneous and IDMT)
- Auxiliary Relays (timers, multitrips, followers etc)

The graph below apportions these categories :

Relay Profile



Auxiliary relays represent the largest category and whilst installed in all protection schemes can be considered as secondary components. It is, however, the remaining four categories that comprise the primary components of any protection scheme.

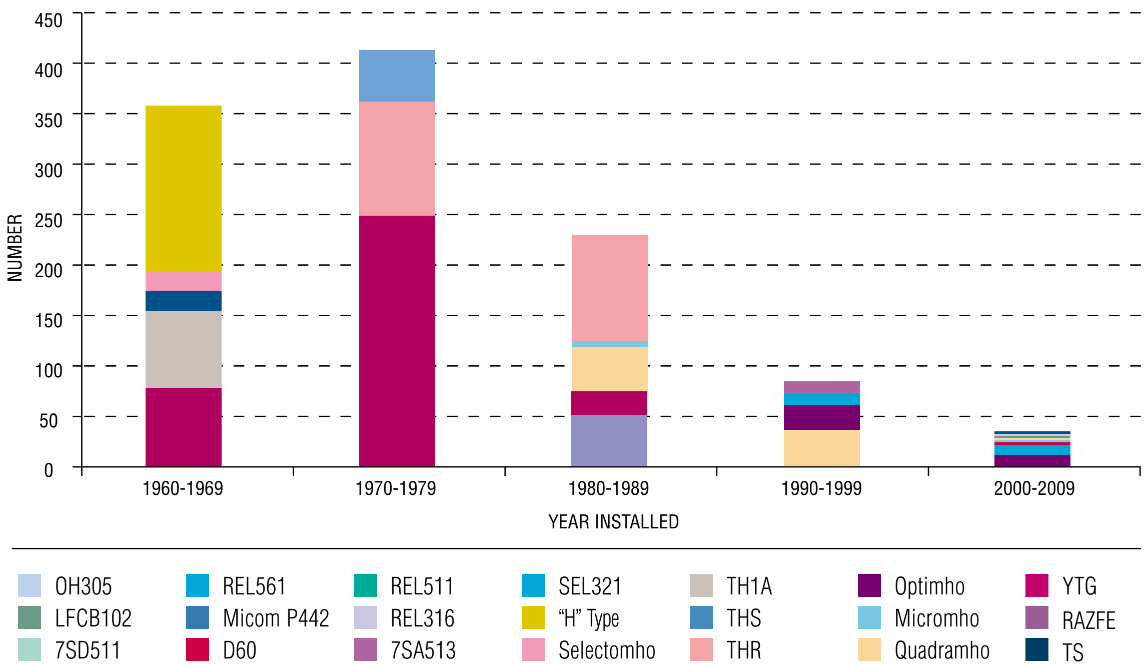
The population, age and performance of this equipment represent some of the factors that need to be considered when determining a 30 year replacement program. The replacement program would also need to include the upgrading of auxiliary relays as a natural consequence of any primary relay change.

It is recognised that most primary relays currently installed on TransGrid's system will need to be replaced. The population and age of the primary protection equipment installed on TransGrid's network is set out in the following pages.

Line Protection Relays

TransGrid's line protection relay population comprises 1,119 individual schemes ranging in age from 0 to 30+ years. The age profile shown below indicates that 70% of TransGrid's distance relay population was commissioned before 1980, some of the oldest schemes were manufactured in the 1960s.

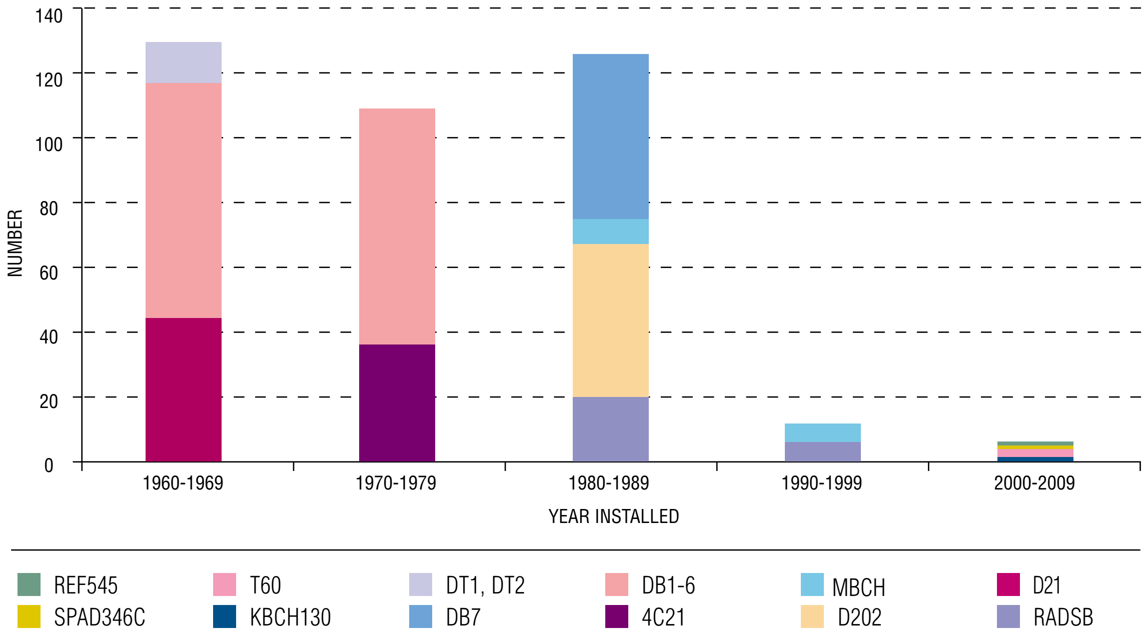
Age Profile of Line Protection Relays



Transformer Differential Relays

TransGrid's transformer differential relay population comprises 378 individual schemes ranging in age from 0 to 30+ years. The age profile shown below indicates that 64% of TransGrid's distance relay population was commissioned before 1980, some of the oldest schemes were manufactured in the 1960s.

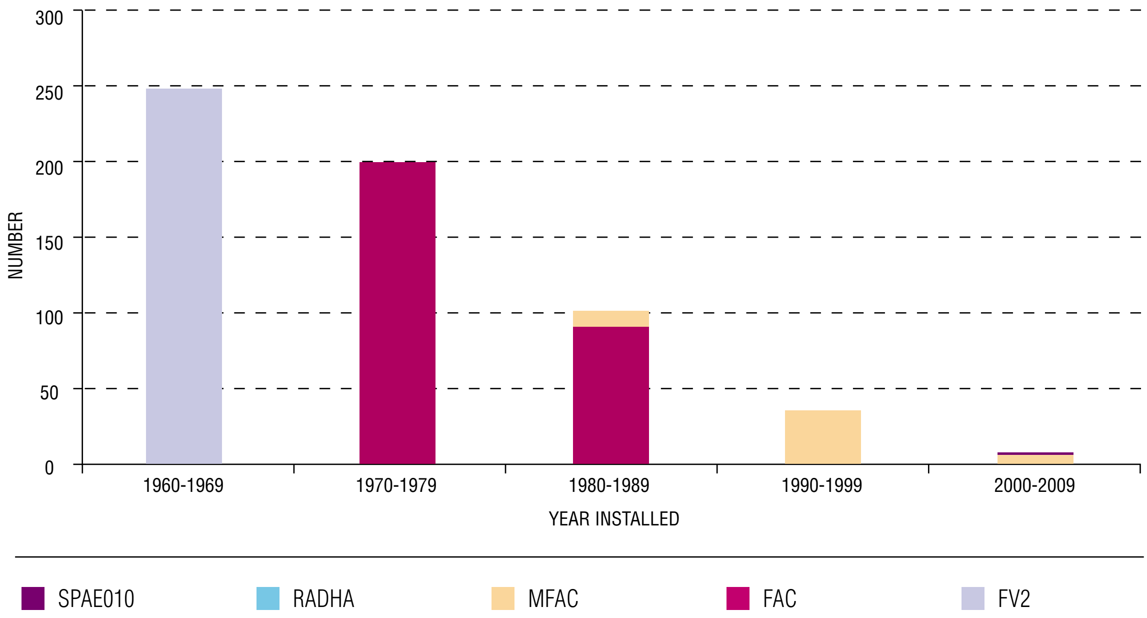
Age Profile of Transformer Diff Relays



Busbar Protection Relays

TransGrid's busbar protection relay population comprises 599 individual schemes ranging in age from 0 to 30+ years. The age profile shown below indicates that 76% of TransGrid's busbar protection relay population was commissioned before 1980, some of the oldest schemes were manufactured in the 1960s.

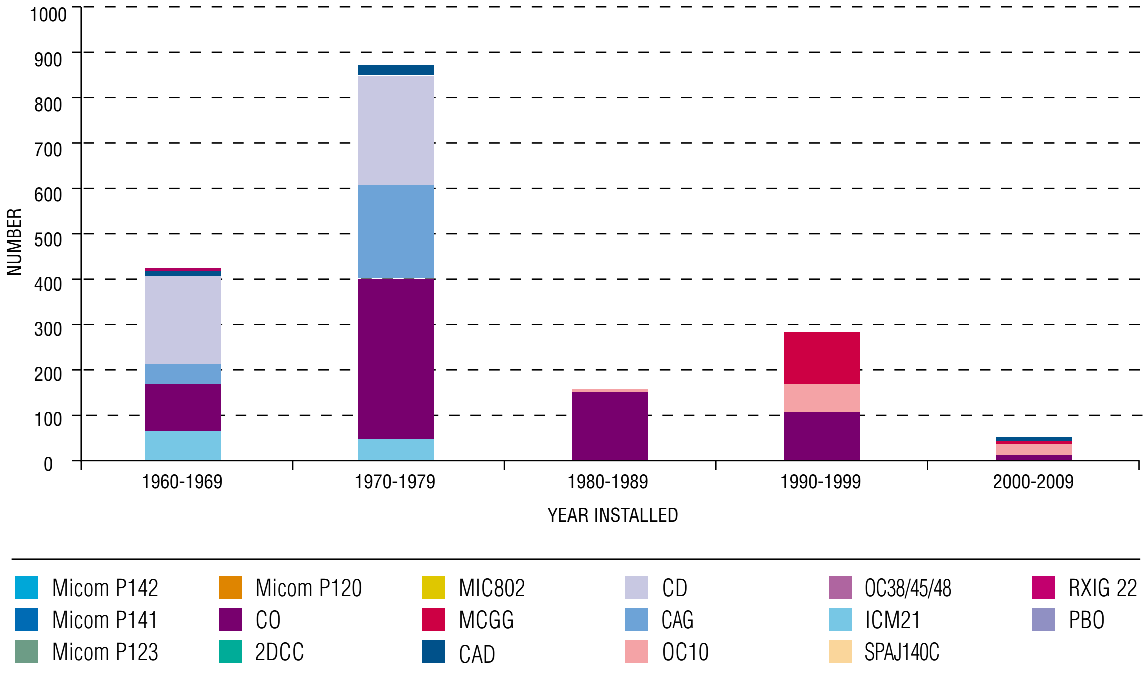
Age Profile of BBP Relay



Overcurrent Protection Relays

TransGrid's overcurrent protection relay population comprises approximately 1,799 individual relays ranging in age from 0 to 30+ years. The age profile shown below indicates that 23% of TransGrid's overcurrent protection relay population was commissioned before 1970, some of the oldest schemes were manufactured in the 1960s

Age Profile of Overcurrent Relays



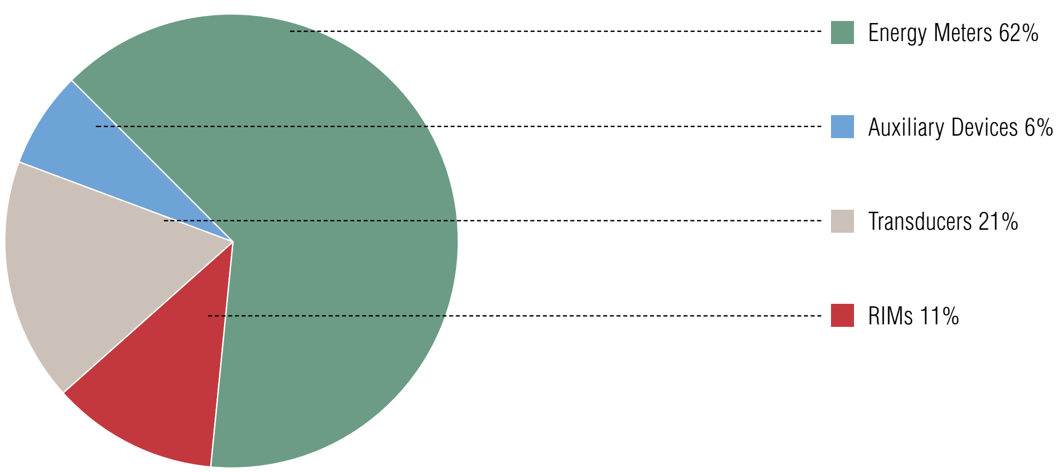
5. Metering

Metering equipment at TransGrid sites can be grouped into a number of broad categories. These include :

- Energy Meters
- Remote Interrogation Meters
- Auxiliary Devices (voltage selection relays, transformers etc)
- Transducers

The graph below apportions these categories :

Metering Installation Profile



Energy Meters represent the largest category and when combined with Remote Interrogation Meters (RIMs) and Auxiliary Devices form the essential components of any Revenue or Backup metering scheme. Transducers form the second largest category and provide an important function in relation to system operations.

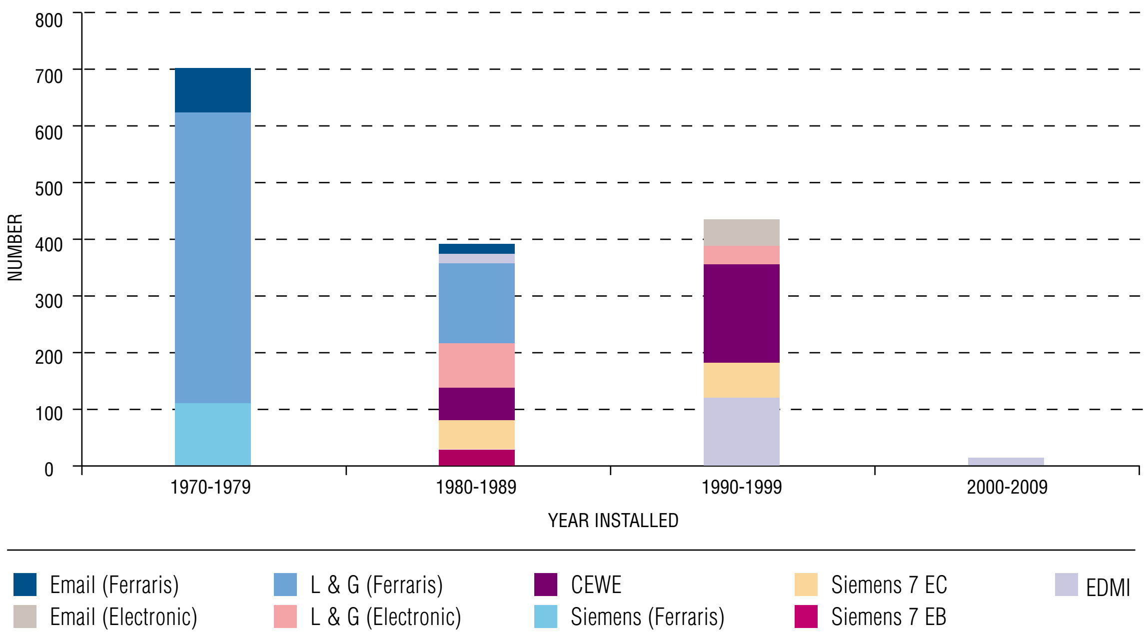
A replacement program would include the upgrading of selected auxiliary devices as a consequence of any Revenue or Backup metering scheme review. For example, the voltage selection relay may be changed, but the 110V/240V auxiliary supply transformer would not generally require replacement.

It is recognised that most energy meters, RIMs and transducers currently installed on TransGrid's system will need to be replaced. The population and age of the primary metering equipment installed on TransGrid's network is set out in the following pages.

Energy Meters

TransGrid's energy meter population comprises 1,524 individual units ranging in age from 0 to 30+ years. The age profile shown below indicates that 46% of TransGrid's energy meter population was commissioned before 1980.

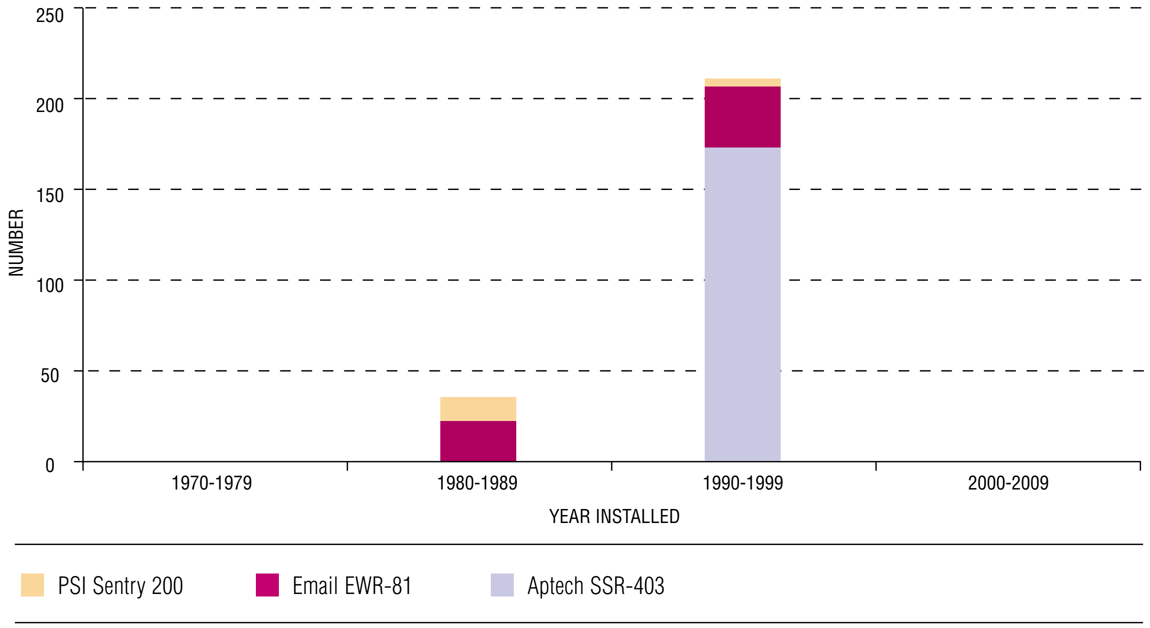
Age Profile of Energy Meters



Remote Interrogation Meters (RIMs).

TransGrid's datalogger (RIM) population comprises 247 individual units, the majority of which are 0 to 10 years of age. The age profile shown below indicates that 85% of TransGrid's RIM population was commissioned after 1990. This was primarily due to the phasing out of older Magnetic Tape Pulse Recorders in the late 1980s as a consequence of the development and increased availability of RIM devices.

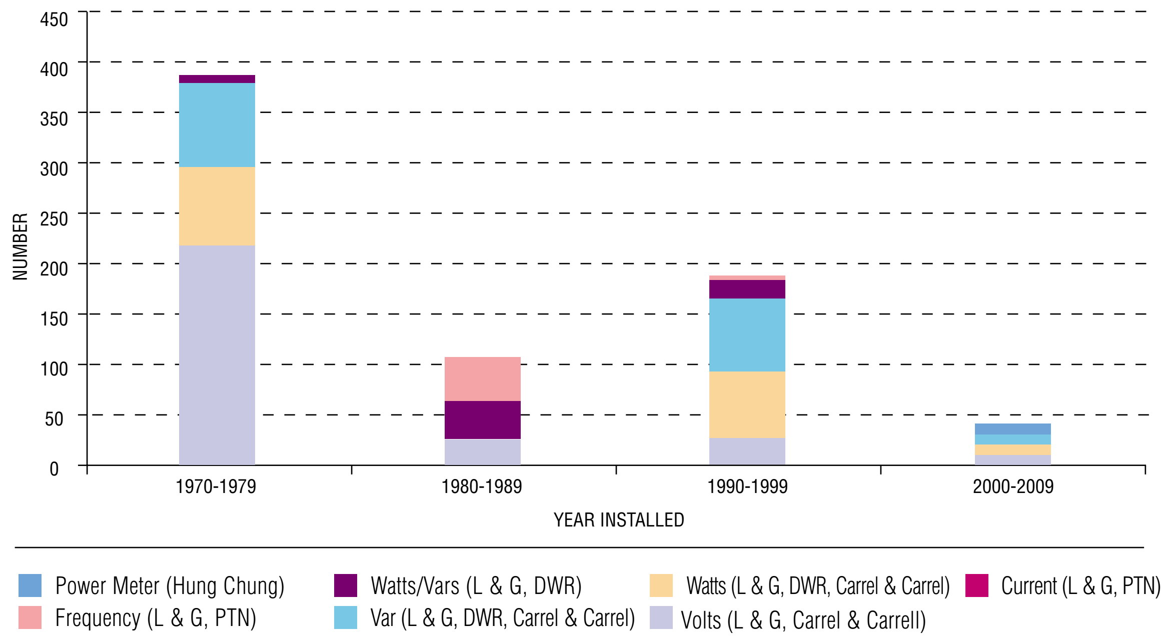
Age Profile of RIM Devices



Transducers

TransGrid's transducer population comprises 726 individual units ranging in age from 0 to 30 years. The age profile shown below indicates that 60% of TransGrid's transducer population was commissioned before 1980.

Age Profile of Transducers



6. Communications

TransGrid owns 66 communication rooms located within substations, Regional Centres and TransGrid's head office.

Each communication room provides voice, data and protection services to the equipment and staff on site. Being part of the site the communication room utilises the ancillary equipment installed.
TransGrid own 62 microwave and VHF radio repeater sites located across NSW.

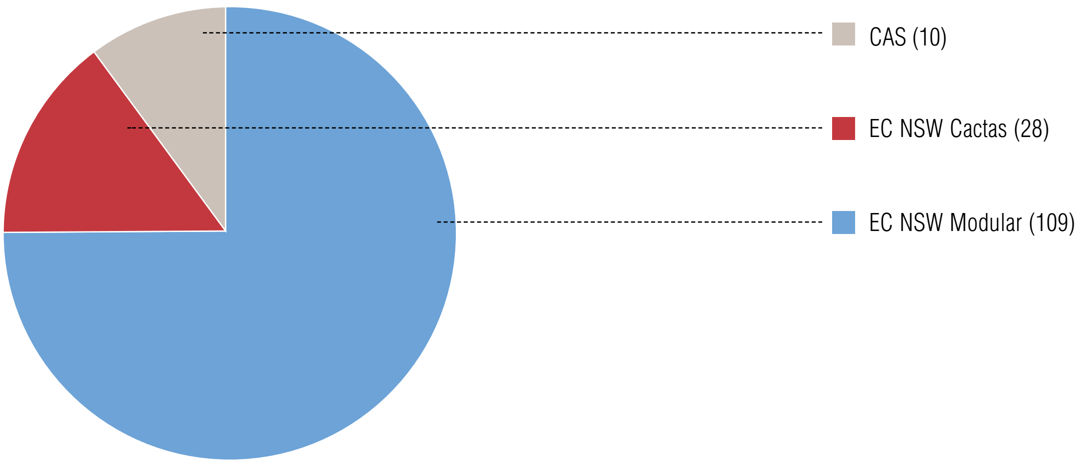
All Repeater sites are stand-alone and have individual ancillary equipment. These include power and lighting, battery and chargers, air conditioning, access roads, security fencing and radio towers, poles or structures.

Data on all equipment is listed below.

Bay Alarm Systems

Each Communication room marshals individual alarms from equipment and displays them as an audible and visual display. This is achieved by the Bay Alarm System. Three types provide the service at present. . Modular Bay Alarm (1982) is discrete component solid state equipment based on transistors and mechanical relays. CACTAS Bay Alarm (1990) is a solid state system. Each of these systems produces local alarms with only onsite interrogation available. Computer Alarm System (CAS) (2000) is a microprocessor based alarm system, which allows remote interrogation and control.

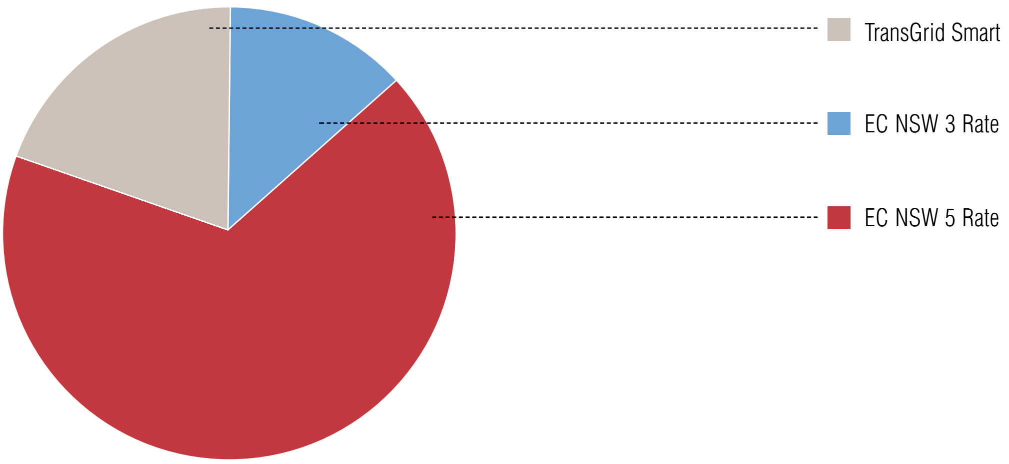
Bay Alarm Systems



Backup Alarm Systems

TransGrid owns 137 backup alarm systems that provide a combined alarm service as a secondary service to SCADA or LCSS systems. 3 Rate Alarm (1963) is a mechanical relay based system capable of transmitting 3 single alarms determined on rated priority. 5 Rate Alarm (1982) is an OP AMP based system capable of transmitting 5 single alarms determined on rated priority, SMART alarm (1997) is a microprocessor-based system capable of transmitting and receiving 10 simultaneous alarms. The 3 and 5 Rate alarm systems will be progressively replaced by SMART alarms.

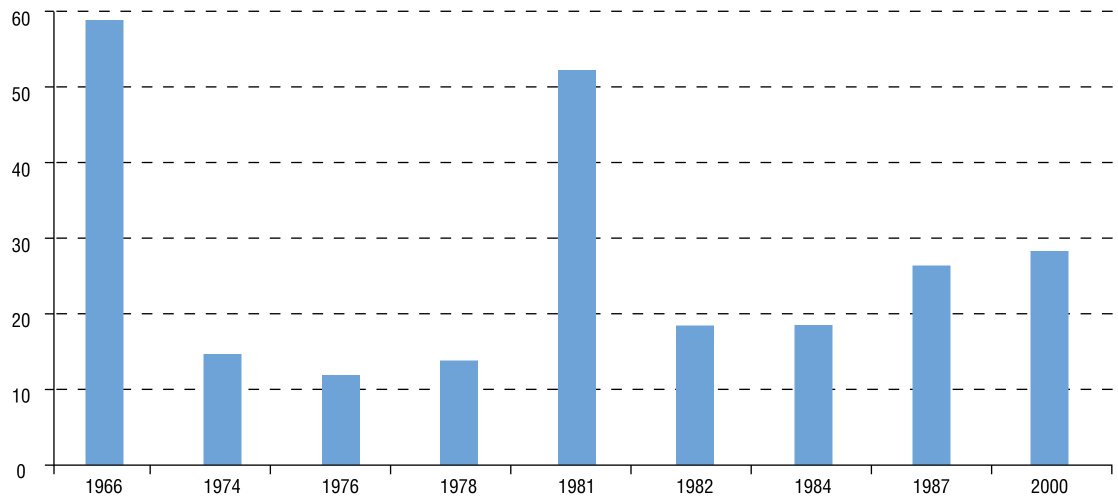
Age Profile of Back-up Alarms



Power Line Carrier

TransGrid owns 258 Power Line Carrier systems that provide communication services between substations. These systems carry Voice, SCADA and Backup alarm systems.

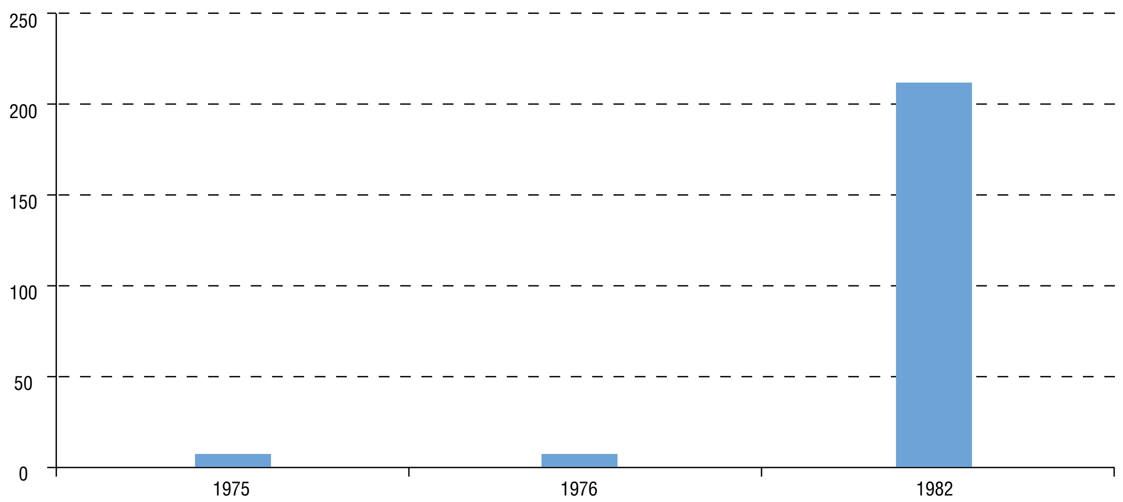
Voice PLCs Installed



Power line Carrier Protection Intertrip Systems

TransGrid owns 254 PLC Intertrip system. These systems provide Intertrip function over Transmission lines.

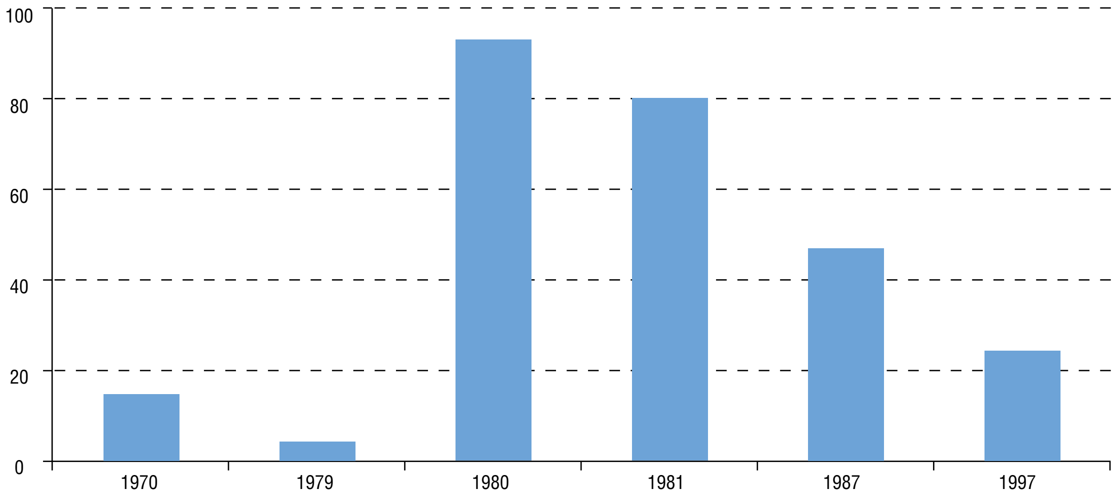
PLC Protection Interstrips Installed



VF Protection Intertrip Systems

TransGrid owns 276 VF Intertrip systems. These systems provide Intertrip function over Voice Frequency bearers (Microwave, Optic Fibre and Cable Carrier).

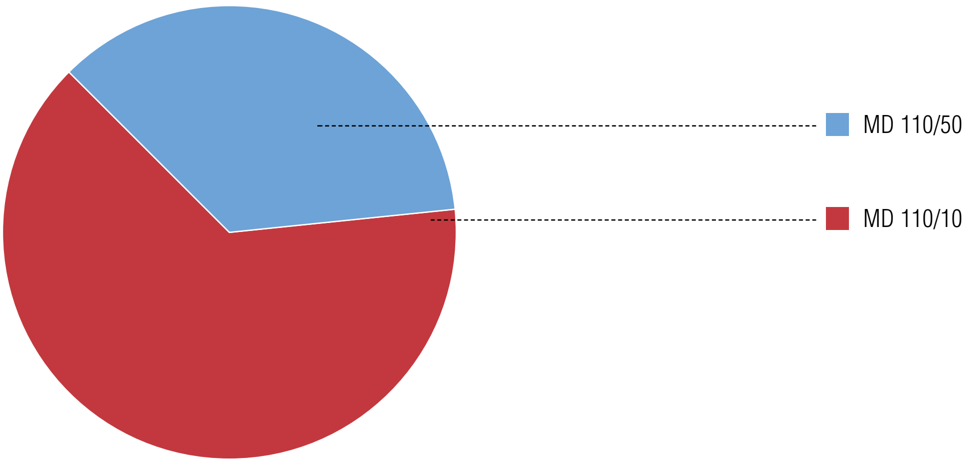
VF Intertrips Installed



Telephone Equipment

TransGrid owns and operates 64 networked telephone exchanges. These exchanges provide voice communications to all major sites and substations. The exchanges operate using 4 different versions of software (BC6, BC6.3, BC7and BC9). The 64 exchanges were installed between 1990 and 1991 with the 4 versions of software being installed and upgraded at selected sites from 1990 to 1997. The entire TransGrid Corporate Telephone Network will be upgraded to BC10 in the Financial Year 2001/02.

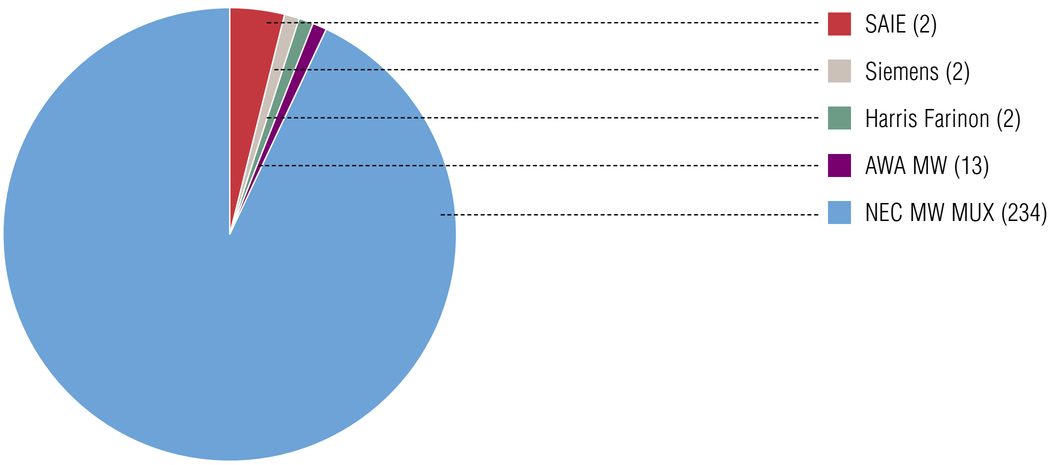
Exchange Types



Microwave Radio Equipment

TransGrid owns and operates a communication network with the major backbone of the network being Microwave radio. The backbone comprises of Southern and Western analogue systems and Northern and spur digital systems. The microwave radio system will be largely replaced by OPGW running Fujitsu terminal and multiplex equipment. The remaining spur microwave radio systems will be replaced by Alcatel microwave radios running Fujitsu multiplex equipment identical to that used on the OPGW system.

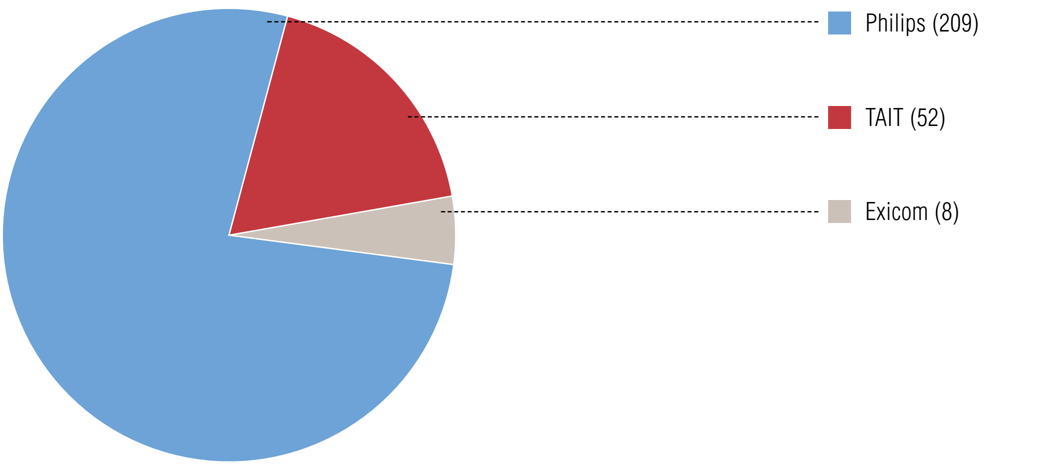
Microwave Radio Types



VHF Radio Equipment

TransGrid owns and operates a VHF Radio network covering all major transmission feeders in NSW. Philips manufactured the majority of the equipment in 1981 with the remaining Exicom equipment manufactured and installed in 1996. The current Philips FM814 repeater equipment will be replaced by TAIT 2000 series equipment.

VHF Radio Types



4.3.2 Specific Asset Maintenance Strategies

Introduction

This section describes the specific maintenance policies and refurbishment and replacement strategies that have been developed to ensure the continued performance of the existing network assets. Staff carrying out inspection of equipment constantly monitor the condition of the assets and data is analysed to determine the appropriate course of action.

1. Substations

Routine Maintenance

Routine maintenance is carried out in accordance with the TransGrid Substation Maintenance Policy. The principles employed include the following:

- External condition monitoring is used whenever possible.
- Plant is tested in regular intervals that vary depending on a number of factors including plant type, previous experience, manufacturer's recommendations.
- For all major plant detailed Service Instructions have been prepared and are being used by field maintenance staff.
- Regular site inspection of all installations is carried out on at least a three-monthly basis.

Circuit Breakers - Circuit breakers are maintained on either time or operational basis. The table below summarises the different maintenance types and frequencies.

Type of CB	Inspection	Minor	Major	No. of Operations
Oil	3 monthly	4 yearly	12 yearly	800
Air blast	3 monthly	4 yearly	12 yearly	800
SF6	minor: 3 monthly major: 4 yearly	8 yearly	16 yearly	2 500

In addition the duration of the maintenance also depends on circuit breaker type. For example on air blast 330kV circuit breakers there can be up to 24 interrupting heads, while a modern SF6 330kV unit for the same duty has only 6 heads.

Types of diagnostic testing carried out on circuit breakers include: measurement of contact resistance, speed of operation of contact opening and closing, insulation medium tests, checks on operating mechanisms etc.

Power Transformers and Oil Filled Reactors - power transformers have four main components (tapchanger, bushings, windings and oil) that require routine maintenance on either time or operational basis. The table below summarises the different maintenance types and frequencies.

Component	External Inspection	Minor Maintenance	Major Maintenance	Number of Operations
Tapchanger	3 monthly	4 yearly	4 to 8 yearly	Depends on type and make of unit
Bushings	3 monthly	N/A	4 yearly	N/A
Windings	N/A	N/A	4 Yearly	N/A
Oil System	3 monthly	Annual Sample	As Required	N/A

The frequency of maintenance also depends on transformer / reactor condition and to some degree on its type. Oil samples are taken for Dissolved Gas Analysis (DGA), Furans and Oil Quality tests.

More recently, on-line condition monitoring facilities are being developed and installed on selected power transformers and oil filled reactors. These devices provide continuous monitoring of the condition of the equipment while they remain in service and include early warning of any internal problems that could reduce the incidence of unexpected major failures.

Instrument Transformers - Instrument transformers include current transformers and voltage transformers. Most voltage transformers are of the capacitive type and a purpose built on-line voltage unbalance system developed by TransGrid is used to monitor their internal condition.

All current transformers are tested externally by measuring dielectric dissipation factor (DDF) and oil sampled. Oil tests include dielectric measurements and dissolved gas analysis (DGA) tests. Normal method of testing is a 4-yearly cycle with more frequent tests if results indicate a need.

Similar to power transformers, on-line condition monitoring facilities are also being developed and installed on selected current transformers to detect internal problems that could reduce the incidence of unexpected major failures.

Other Plant - Other plant such as disconnectors, surges arrestors, capacitor banks etc. are maintained at service intervals the same as the main plant. Batteries are maintained in accordance with our service experience, basically at 2 yearly intervals.

Non-Routine Maintenance

Non-routine maintenance covers breakdown repairs, defect repairs, plant modifications and other work not covered by routine maintenance.

Major Operating Projects

Major Operating Projects are non-routine work requiring substantial resources, that are non- repetitive in nature. They include both refurbishment and replacement of equipment and may also include capital work such as the installation of new high technology condition monitoring systems onto existing plant.

The following factors are used to identify, analyse and substantiate any new major operating project:

- Need for work based on issues such as performance, maintenance needs, safety, lack of spare parts, environmental factors, type faults etc;
- Risk assessment analysis associated with continued repairs, future reliability, system security;
- Total quantity and costs which may consider either refurbishment or replacement options;
- Time period over which the work has to be done; and
- Priority factor giving importance relative to other projects.

In general all replacement programs are determined by condition, economic, safety or environmental considerations rather than by age alone.

Increasing use of condition monitoring is being made to substantiate equipment replacement and refurbishment. On-line continuous condition monitoring systems are becoming available for a wide variety of substation plant such as power transformers and oil filled reactors, bushings, on-load tapchangers, circuit breakers, instrument transformers and protection relays.

TransGrid has implemented a strategy to purchase a range of these on-line monitoring systems for installation at selected locations initially, and then to include other sites as considered appropriate.

Power Transformers and Oil Filled Reactors

Investigations into performance of transformers have identified potential issues that may impact on the expected operational life of these units. These issues relate to problems with on-load tapchangers, high voltage bushings, loose windings, cooling systems, oil quality and moisture ingress. All of these issues when identified early enough can be satisfactorily and economically managed thereby ensuring the continued performance of the transformer or reactor.

Existing condition monitoring and maintenance practices such as regular visual inspections, oil sampling and major maintenance of transformers and oil filled reactors identify those issues that require oil treatment, refurbishment or repair.

The types of refurbishment programs applicable to most power transformers and oil filled reactors include the following work:

- refurbishment or replacing of insulating oil to improve quality;
- drying out to reduce moisture content in paper and oil;
- retighten and reclamping loose windings;
- replace faulty high voltage bushings;
- repair of oil leaks;
- painting and corrosion repairs;
- refurbish or replace tapchanger including sealing of diverter compartment; and
- refurbishment of cooling, control or protection equipment.

Depending on local operating conditions, most transformers and reactors over 30 years old are subjected to refurbishment programs that are repeated every 20 years.

In addition, TransGrid implements projects on specific transformers or reactors to maximise the useful service life of the units. Some of these projects include:

- Fitting of oil conservator bags to minimise oxidation and moisture ingress initially on all transformers less than 20 years old;
- Fitting of filters and dehumidifier units to on-load tapchangers that are subject to more than 15,000 operations per year;
- Fitting of on-line continuous monitoring systems to the on-load tapchanger, high voltage bushings, transformer oil and thermal systems on all critical transformers; and
- Relocation of transformers or reactors to other substations within TransGrid's network to better utilise or match their design ratings against the substation loadings and to defer expenditure on new transformers and reactors.

Once a transformer or reactor is assessed to have reached the end of its reliable service life a replacement unit is installed. Normal procedures require that before any replacement unit is procured a review is performed to determine the optimum rating required.

Also, contained within the NSW Annual Planning Statement any specific network constraints are identified where existing substation transformer thermal capacities are not able to meet the required loads. For these situations the two normal options considered include the installation of extra transformers into the substation or the replacement of the existing transformers with higher rated units. Depending on the condition of the units replaced they are either refurbished and relocated to another site or stored as spare units.

Circuit Breakers

There are three main types of high voltage circuit breakers in use on TransGrid's network, air blast, small oil volume and SF6.

Both the air blast and small oil volume circuit breakers are now considered to be obsolete technology due to their complicated design and the large numbers of parts that are no longer available. Maintenance costs for these two types of circuit breakers (including air systems for air blast type) are high, and a substantial level of maintenance knowledge and effort are required to ensure continued reliability of the circuit breakers.

Poor performance on air blast and small oil volume circuit breakers usually relates to timing problems with the breakers operating either slowly or with greater than acceptable phase discrepancies. CIGRE statistics indicate an expected economic life of circuit breakers to be within the range 25 to 35 years and this is consistent with TransGrid's service experience.

Subject to an economic evaluation in each case, a program of phasing out of air blast and small oil volume (SOV) circuit breakers within TransGrid commenced in 1995. In particular there are specific strategies for replacement of the following circuit breakers.

Type and make of Circuit Breaker	Voltage	Project Time Frame
Air Blast- Reyrolle OBR 60	330kV	by 2003
Air Blast- Reyrolle OBR 30	132kV	by 2004
Air Blast – AEI GA11W8	330kV	by 2004
Air Blast – Merlin Gerin PPTY 77	132kV	by 2003
Air Blast- AEG WM5077	132kV	by 2005
SOV-Oerlikon FR	132kV	by 2005
SOV-Oerlikon TOF60.6	66kV	by 2003
SOV- Galileo OCEO	66kV	by 2003
SOV-Galileo OCERD	132kV	by 2004
BOB – BTH	66kV	by 2004

Although modern SF6 circuit breakers have proven to be reliable and need minimum maintenance, early generation SF6 circuit breakers supplied between 1975 and 1987 suffer from type faults leading to corrosion and SF6 gas leaks. Refurbishment programs have commenced to rectify these problems.

Switching of large shunt capacitor banks can result in transient voltage disturbances that impact on the performance of end use customer equipment. To minimise voltage disturbances point-on-wave switching technology is to be incorporated into the circuit breaker design at a number of locations.

On-line continuous condition monitoring systems have recently become available to monitor circuit breakers and a program has commenced to assess the effectiveness of these different systems.

Instrument Transformers

TransGrid's instrument transformer maintenance policy provides for regular inspection and testing to detect any units that may need specific attention.

Replacement of instrument transformers is generally carried out based on condition monitoring results of the insulation system. For current transformers oil samples and dissolved gas analysis has been the most commonly used monitoring method.

On-line condition monitoring devices have been used by TransGrid on capacitor voltage transformers for some time, where a voltage unbalance alarm indicates a potentially faulty unit and, if confirmed, the unit is replaced. Similar devices are now being considered to continuously monitor current transformers within a switchyard.

Synchronous Condensers

The two Synchronous Condensers at Sydney South substation have been in service since 1962 and have progressively undergone major refurbishment. Both units require extensive maintenance to keep them operational and both units will require further major refurbishment work over the five years in order to maintain acceptable levels of operational performance.

Details of the proposed work to be performed on both units are summarised in the following table.

Type of work required	Proposed date for work
Rewind Stator Windings	2002-2005
Refurbish Cooling Towers	2002-2003
Replace 16kV Switchgear	2002-2003
Refurbish Starting Transformer, Phase Isolated Bus and Hydrogen Storage Facilities	2002-2003

However, the recent decision to replace both of these synchronous condensers with the modern alternative of Static Var Compensators by 2003 will significantly affect and possibly cancel any proposed refurbishment work unless considered urgent.

Static Var Compensators (SVCs)

Of the six SVCs owned by TransGrid, the two units located at Kemps Creek, which were commissioned in 1990, have not provided the expected level of reliability.

Issues relating to the electronic control systems in the Kemps Creek SVCs have resulted in a shortage of available spare parts that restrict the full operation of both units. The manufacturer has indicated that the control technology used on these SVCs is now outdated and future availability of spare parts is not assured. Consequently proposed upgrading of the Kemps Creek SVCs' Control Systems is scheduled from 2002.

Gas Insulated Switchgear (GIS)

The Gas Insulated Switchgear located at Beaconsfield West was commissioned in 1979 and the manufacturer has recently indicated that the implemented technology is outdated and therefore the future availability of spare parts is not assured.

Detailed investigations during 1995/96, involving the manufacturer confirmed that the condition of the equipment is quite good. An assessment of spare parts required to ensure the long term performance of this equipment up to 2006 has been performed and procurement action initiated. Refurbishment of existing Circuit Breakers and Gas Chambers is scheduled for 2003–2006 after the commissioning of the new substation at Haymarket.

Shunt Capacitors

TransGrid has 77 shunt capacitor bank installations of various configurations ranging in voltage from 11kV to 330kV. All PCB filled capacitors have been replaced and it is for this reason that the majority (90%) of existing capacitors have been manufactured and installed since 1980.

Unlike most other items of electrical equipment the condition of power capacitors cannot be monitored and hence the estimated life of these capacitors is expected to be between 25 to 35 years. Therefore existing capacitor banks are expected to be replaced because of normal ageing factors from about 2010 at the rate of 100MVAr per year. This does not impact on the period of this Plan.

One of the Non-PCB fluids introduced in 1980 was the chemical "Dow C4" and at present 24 capacitor banks contain this fluid (total of 985MVAr). Environmental regulations are now becoming apparent that this fluid requires similar handling and disposal methods as that developed for PCB. Hence significant expenditure is required to dispose of any failed Dow C4 capacitors. A major replacement / disposal program for these Dow C4 capacitor banks may commence from approximately 2010 and could take up to ten years to complete.

Batteries and Battery Chargers

Every TransGrid substation and switching station contains a number of batteries and they provide a vital link in the reliable operation of the network. Different batteries are used for the substation protection/control schemes than that used for the communication schemes.

All of TransGrid's batteries except at two sites are of the Nickel Cadmium type. The two exceptions are presently Lead Acid type and are due for replacement within the next 5 years.

All existing batteries are in good condition with regular maintenance and condition checks being carried out. The batteries are replaced when their capacity drops below 70% and this generally occurs after 20 years into their life. Battery chargers are normally replaced when spare parts are no longer available.

Surge Arresters

The maintenance of surge arresters is usually carried out when the associated equipment is removed from service which is generally a 4 yearly cycle. Whilst testing for moisture ingress can be carried out economically, testing for block deterioration can prove to be expensive.

Due to the possibility of the older surge arresters requiring more frequent testing and the impact that such a program would have both economically and in terms of availability, a replacement program for arresters over 35 years of age has been initiated. This program will commence with the replacement of all "gapped" silicon carbide units still in service.

Bushings

TransGrid has a bushing population of approximately 1685 bushings. They are predominantly installed in transformers and reactors and are the means by which a HV conductor passes through earthed metal work. All HV bushings are of a condenser construction and generally take one of the following forms: Oil impregnated paper; Resin bonded paper (SRBP); Resin impregnated paper.

As is the case with any solid or liquid insulation, aging and degradation of insulating properties will occur as a result of prolonged electrical, thermal and mechanical stresses and it is these factors that will generally determine the life expectancy of bushings. Generally a service life of 30 years could be expected from bushings provided other factors do not come into play. SRBP bushings by the nature of their manufacture have a much higher level of failure than the other types as a result of delamination of the layers and void formation.

Bushing failures often have far reaching effects that extend beyond the loss of bushing itself as often a failure may lead to the loss of a transformer through fire.

Maintenance on bushings is generally integrated into the transformer maintenance and involves the measurement of DDF via a test point located on the flange. Where no such test point exists assessment of the bushings condition becomes difficult unless it is removed from the transformer.

Control Systems

By 2002-3, the Yass 330kV substation will need to undergo a major refurbishment of its control and alarm schemes including the replacement of most of its switchyard cabling. Depending on the technology adopted, this replacement work may also include all the protection and metering schemes. However, more recent plans for Yass now indicate that the complete substation may need to be replaced by 2004-2005 and therefore any proposed refurbishing work will be cancelled.

The techniques and refurbishing methods proposed for Yass will now be considered for other 330kV substations such as Sydney South by 2004 and Sydney West, Sydney North, Canberra and Dapto in future years.

Other Substation Plant

Other equipment such as disconnectors, earth switches, cables, light and power circuits, fire fighting equipment, security equipment, etc. are all monitored and refurbished or replaced as required.

Substation Property and Buildings

All buildings, fencing, roads, civil structures, drainage systems, landscaping, environmental buffer zones and other services are monitored and refurbished or replaced as required. Redundant buildings in need of extensive maintenance will be progressively demolished.

2. Transmission Lines

Routine Maintenance

A routine maintenance strategy is in place to ensure that all transmission line structures are regularly inspected. The inspections aim to detect likely component aging or defects such that remedial work can be undertaken to ensure no loss of supply will occur. The location of the assets, past performance and the material or form of construction determines the inspection intervals.

Inspection cycles have been reviewed and categorised into maintenance regimes based on past performance, current condition and line importance. All transmission lines are visually inspected at least once per year.

A summary of maintenance requirements is shown in the table below:

Construction	Risk Category	Inspection Requirements
Steel Tower, Steel Pole & Concrete Pole	High	Annual Ground Patrol Annual Aerial Patrol 10 yearly Detailed Aerial Patrol
	Medium	Ground & Aerial Patrols in alternate years 10 Yearly Detailed Aerial Patrol
	Low	3 yearly Ground Patrol In other years an aerial patrol 10 yearly detailed Aerial Patrol
Wood Pole	High (Structural Concerns)	Staggered Program including: • Groundline inspection & treatment 3 yearly • Climbing inspection 3 yearly • 3 yearly aerial patrol
	High (Vegetation Concerns)	Groundline inspection & treatment 6 yearly Climbing inspection 6 yearly Ground inspection in years no climbing or groundline inspection Annual aerial patrol
	Low	Groundline inspection & treatment 6 yearly Climbing inspection 6 yearly Alternating ground & aerial patrols in years no climbing or underground inspection

Non-Routine Maintenance

A major facet of the non-routine maintenance is easement vegetation control where growth rates of plants and trees are largely a function of climatic conditions and as such cannot be predicted very far in advance. Where necessary suitable access to the lines is provided and maintained.

In some instances type defects, such as insulator degradation, can be identified and extra resources channelled to determine the extent of the problem or to apply corrective action.

Major Operating Projects

No major issues exist with transmission lines that require rectification in the short term. A number of emerging medium to long term issues have been identified. Detailed long-term strategies are being developed to manage these emerging issues.

A number of current minor issues and their strategies are shown below.

Insulators

Where problems are identified with insulators, or where insulators are in excess of 25 years old, batches of that type of insulator are taken out of service for testing. Should testing confirm a type problem then a strategy is developed to deal with it. Conversely, if the problem is an isolated one, then a watching brief will be maintained on that type of equipment.

Overhead Earthwire Replacement

Earthwire is replaced due to fault rating limitations or corrosion problems. Fault rating limitations have occurred on sections close to substations where fault levels have risen over time. There has been a program over several years to uprate these sections to meet their expected duty cycle. Other lines will be reviewed when upgrading of lines/substations is proposed.

Galvanised steel earthwire close to marine or industrial environments suffers from accelerated corrosion. Amongst the most susceptible are the lines between Sydney and Dapto, which are showing significant, pitting of the steel strands. Replacement is programmed for completion by the end of 2001.

Vibration Dampers

Some 132 kV lines were originally installed without vibration dampers. Fatigue of strands has occurred due to the lack of damping capability on the spans, which in some cases has lead to the conductor failure. A strategy has been developed whereby all remaining undamped lines are fitted with dampers in accordance with current design practice.

Wood Poles

Wood poles are generally replaced following detection of significant defects during routine maintenance. In the past less than 1% of the pole population has been replaced each year. However, the defect rate is anticipated to increase to 4% over the next ten years as the wood poles reach their average life expectancy. A strategy has been established to replace wood poles with steel or concrete poles which will reduce the anticipated 'peak' in replacement rates and provide infrastructure with low maintenance and long life. Significant rot has been identified in poles on several lines requiring considerably higher replacement rates and these lines are programmed to be the first in the replacement strategy.

Composite Wood Pole Structures

A number of wood pole transmission lines were uprated in the past by the use of wood pole extension joined to the existing poles by steel jointing sleeves. These composite pole structures raised the conductors allowing increased thermal rating of the circuit.

A number of issues have arisen with respect to these structures including pole rot occurring behind the jointing cylinder. A strategy has been implemented to replace these structures at high-risk locations. A progressive program is to be undertaken to rebuild these lines to steel or concrete construction as their condition warrants.

Grillage Foundations

Early practice in steel tower construction, particularly where access was difficult, was to place a steel quadraped on the bottom of each tower leg and back fill with earth. Over time the reaction of the acids in the soil have slowly corroded the zinc coating and now the steel of many towers. Early strategies here have focussed on encasing the leg with concrete to prevent further corrosion. A more cost effective and quicker method using sacrificial anodes has been developed to protect the remaining steel of the tower foundations. All applicable steel towers are expected to be treated by 2003.

Concrete Poles

Corrosion of the steel reinforcing in concrete poles has been noticed in areas with high water tables of high saline content.

A small number of existing poles will need to be replaced within the next 10 years.

3. Underground Cables

The 330kV Sydney South – Beaconsfield West Cable 41 circuit was commissioned in 1979. The cable and cable accessories were manufactured and installed by Sumitomo/Japan under Contract 2609 (Mitsui). This is currently TransGrid's only high voltage cable (outside substation boundaries), until the commissioning of the next 330kV cable 42 from Sydney South to the new substation at Haymarket in late 2003.

Routine Maintenance

Routine maintenance is carried out in accordance with the TransGrid Underground Cable Maintenance Policy. The principles involved include:

- Cable route patrol and maintenance
- Reading and recording of cable fluid pressure gauges
- Checking of accuracy of cable pressure alarms
- Sampling and testing of cable fluid
- Inspection of cable sealing ends
- Testing of cable outer sheath and link box maintenance
- Monitoring of joint movement

The frequencies of these activities are set out in the Policy.

Non-Routine Maintenance

Due to the nature and location of the underground cable in public roads and footways, various defect repairs and modifications not covered by Routine Maintenance are carried out. These need to be assessed on a case-by-case basis.

Major Operating Projects

Temperature Monitoring and Real-Time Rating

The thermal rating of Cable 41 has recently become important for a number of reasons:

- Increased loading, particularly during summer days, has meant that currently applied cyclic ratings are being reached on a number of occasions. In addition, contingency considerations mean that the ability to obtain outages on other critical items of plant in the Sydney area is becoming increasingly limited;
- Investigations by TransGrid have identified the capacity for safely increasing the rating of the cable under a number of operating conditions; and
- Recent information on the thermal impact of deeply buried sections of cable has identified the potential for "hot spots" in the cable that could accelerate cable paper deterioration at these locations and affect long-term cable reliability.

Preliminary assessments have indicated that the maximum operational benefit and risk control will be obtained by the implementation of a real-time cable rating system. This system is designed to measure cable sheath and soil temperatures at a number of critical locations and to compute normal and emergency cable ratings available in real time. This work is expected to be completed by 2003.

Oil System Modifications

A number of oil system modifications are required. In summary these are to:

- Increase the surplus oil volume in the cable oil system to improve cable security;
- Replace or refurbish oil pressure gauges;
- Evaluate differential pressure gauges, and if successful implement a differential (phase to phase comparison) pressure alarm system which is expected to be considerably more sensitive than the current system;
- Overhaul pressure alarm switches.

This work will be completed by 2002.

Civil Works

The civil structures associated with the Cable 41 circuit are beginning to deteriorate. Remedial work is necessary to prevent more extensive damage resulting from the problems being neglected.

These repairs are scheduled for completion by 2002.

4. Protection Schemes

Routine Maintenance

The routine maintenance policy determines the frequency and extent of maintenance required for a given relay type. A summary is given in the table below.

Protection Scheme	Category	Maintenance Regime
Distance	System critical and relay not self-checking	6 yearly full routine maintenance 3 yearly performance check Annual in-service auto-reclose checks (for circuits with intertrips)
	All others	6 yearly full routine maintenance Annual in-service auto-reclose checks (for circuits with intertrips)
Transformer and Reactors	Single Scheme	4 yearly full routine maintenance
	Duplicate Scheme	4 year full routine maintenance
Busbar	All	6 yearly full routine maintenance 3 yearly performance check
Other Protection Schemes (SVCs, capacitors etc.)	All	6 yearly full routine maintenance 3 yearly performance check

Non-Routine Maintenance

Relays used for the protection system are inspected and tested on a routine basis and where failures or problems are found an investigation is carried out. Subject to the results of such investigations, relays are either replaced, modified or placed under a "watching brief".

Major Operating Projects

A number of staged replacement programs for protection relays are currently scheduled to allow significant improvements to the maintenance performance of these devices on the Network.

In the short term (five years), the above programs form the initial steps in the replacement of selected relay types on the Network. These programs will be supplemented by relay replacements using the criteria for selection as detailed in the 30 year strategy.

In the long term (five to thirty years) relay performance will need to be assessed using certain criteria before being considered suitable for replacement. Such criteria will include on a priority basis :

1) Relay age.
2) Relay failure rates – includes history of particular relay maloperations and the impact on system performance.
3) Relay location and criticality in the Network – includes speed and performance of relays and their "fitness for purpose".
4) The ability to repair a relay and the cost of repair.
5) Relay routine and fault maintenance costs.

To allow a projection for the number of replacement schemes to be developed, the following assumptions have been made:

- All main protection relays will be progressively replaced over a 20 year period.
  (The main reasons being to improve the reliability of protection relays, the ability to remotely interrogate relays as to their status and reduced maintenance requirements)
- The relays would be replaced on a priority basis according to the five criteria identified above.
- Existing relays not targeted for replacement in the period 2000 to 2010 continue to perform satisfactorily.
- Appropriate resources are available to perform replacement programs.
- The expected life of new relays is estimated at between 15-20 years.
- Repair is possible of these new relays during their 15 to 20 year lifetime.

With consideration given to these assumptions and TransGrid's existing relay population, estimates for the replacement program have been developed. These estimates are based on the following action plan:

- Relays currently 20 years of age and older will be progressively replaced in the period 2000-2010.
- Relays currently younger than 20 years of age will be replaced during the period 2010-2020.
- These new relays will themselves need replacement from about 15 years of age.
- Overcurrent relays are included in primary relay replacement.

Other strategies being implemented include:

- To improve fault recorder data, a trial of GPS equipment has commenced to provide a synchronised time base;
- Trial remote interrogation of some modern types of protection relays;
- Installation of a modern fault location unit which uses the travelling wave principle;
- Further development of newer testing methods, which incorporate scheme testing rather than individual relay tests, will improve maintenance techniques and reduce operating costs.

5. Metering Installations

Routine Maintenance

TransGrid is a registered Metering Provider under the National Electricity Market Code of Conduct, qualified to design, install, maintain and repair revenue metering. All metering at transmission network connection points is installed and maintained to Code requirements.

Non-Routine Maintenance

Metering installations are under constant performance review to ensure their compliance with the accuracy requirements of the Code. As problems are identified they are promptly fixed to ensure accurate metering is always available to both the National Electricity Market Management Company and to Customers.

Major Operating Projects

An important factor which should be taken into consideration when developing a 30 year plan for metering is that it must be flexible to cater for the evolving needs of both regulated and unregulated customers in the National Electricity Market. Customer requirements and technological advances will determine what level of metering performance is acceptable. Meters that are currently considered of modern design may become functionally inadequate within a relatively short period of time.

Regulated metering equipment will typically include transducers and statistical meters providing operational and network planning data. Unregulated metering equipment generally includes revenue (including check) meters and RIMs used to collect metering data for the settlement of the National Electricity Market.

Strategies for replacing unregulated metering equipment will largely be determined by the financially responsible customer and are therefore beyond the scope of this document.

Traditionally, the replacement of metering equipment has largely been driven by two main criteria :

1) The inability to repair ageing equipment that has failed in service due to lack of spares and support from the manufacturer.
2) The need to keep up to date with technological developments and the utilisation of these advances in the most efficient manner.

In the short term (five years) a replacement program for regulated metering equipment should be implemented with age being the primary factor in deciding what equipment is to be changed.

In the long term (five to thirty years) equipment performance will need to be assessed before a decision can be made on replacement strategies. Such criteria for assessment will include:

1) Age.
2) Failure rates.
3) The ability to repair the equipment and the cost of repair. (Dependent upon the availability of spares and manufacturer support).
4) Suitability of existing metering equipment to system requirements.

The following assumptions underpin the planned replacement strategy:

- All main meter types will be progressively replaced over a 20 year period.
- The meters will be replaced on a priority basis according to the four criteria identified above.
- Existing meters not targeted for replacement in the period 2000 to 2010 will continue to perform satisfactorily for their intended purpose.
- Appropriate resources are available to perform replacement programs.
- The expected life of new meters and their suitability (fitness for purpose) is estimated at between 15-20 years.

With consideration given to these assumptions and TransGrid's existing metering population, estimates for the replacement program have been developed. These estimates are based on the following action plan:

- Meters currently 20 years of age and older will be progressively replaced in the period 2000-2010.
- Meters currently younger than 20 years of age will be replaced during the period 2010-2020.
- These new meters will themselves need replacement from about 15 years of age.

The estimated number of replacements shown above should only serve as a guide as the actual replacement of meters is the prerogative of TransGrid's customers and not subject to TransGrid determination. It should also be noted that the RIM and transducer replacements may not eventuate as these functions may become integrated into replacement meter and protection relay devices.

6. Communications

Routine Maintenance

Routine maintenance is carried out where appropriate to ensure reliable performance of communication systems.

A summary of some of the key routine maintenance periods is shown in the table below:

Communication Plant Item	Maintenance Period
Analogue Microwave	10 yearly
Digital Microwave	Nil required
Microwave Supervisory Systems	Annually
Microwave & VHF Antenna & Feeders	2 yearly
Line Traps & Secondary Coupling	3 yearly
PLC Intertrips	3 yearly
VF Intertrips	3 yearly
Radio Sites	Quarterly to annually - depending on site
Optical Systems including PCM	2 yearly
VHF Repeater and Link Equipment	Annually

Non-Routine Maintenance

Non-routine maintenance is carried out as required in order to achieve a communication systems availability target of 99.5%. Fault repair and equipment and replacement is priorities with regard to the severity and impact of the fault.

Major Operating Projects

Communication Property and Buildings

All buildings, fencing, roads, civil structures, drainage systems, Radio towers and other services are monitored and refurbished or replaced as required. Redundant buildings in need of extensive maintenance will be progressively demolished.

Bay Alarms

A replacement program is currently under way to provide improved performance on Bay Alarm Systems. The replacement system is designed to increase performance and provide remote interrogation facilities.

The current systems have a high failure rate, insufficient spare parts and is obsolete technology

A new system has been developed and replacement for 20 sites will be complete at the end of 2000 – 2001 financial year. All remaining Bay Alarm Systems are to be replaced from 2001 - 2004 at the rate of 40 per year and again from 2020 – 2025. Due to changes in technology the initial replacement system is to be a microprocessor-based system that provides remote interrogation and control facilities.

Backup Alarm Systems

A replacement program is currently under way to provide improved performance on Rated Alarm Systems.

All 3 Rate and 5 Rate Alarm Systems have been identified for replacement. The main reasons for replacement are deteriorating performance, reliability with age, the inability to obtain suitable spare parts and the limited capacity of the systems.

A new system has been developed named SMART Alarm that will provide a 10-function alarm service in both transmit and receive directions. This system has an expected life of 20 years. The replacement of existing alarm equipment has commenced and is expected to be complete by 2005, at the rate of 30 per year.

Power Line Carrier

There are two main types of Power Line Carriers in use on TransGrid's network, TP1CE7 and TP1DE12. Both the PLC Systems are now considered as obsolete technology.

The total population of Power Line Carrier Systems were manufactured by Fujitsu Denso prior to 1985 and are no longer supported or built.

With several new substations being built new suppliers are being evaluated to provide systems for current and future needs. A program is currently being developed to utilise the systems for new installations.

Existing PLC are expected to be replaced because of normal ageing factors from about 2001 at the rate of 10 to 15 systems per year.

Power Line Carrier Protection Intertrip Systems

There are two main types of Power Line Carriers Protection Intertrip Systems in use on TransGrid's network, Fuji PLC Intertrip Systems C2149 – C2385 and C2764 – C3750.

All existing PLC equipment was manufactured by Fujitsu Denso and is no longer supported by the supplier.

With several new substations being built new suppliers are being evaluated to provide systems for current and future needs. A program is currently being developed to utilise the systems for new installations.

At present there is no evidence that existing PLC Intertrip systems will experience failures and there is adequate spares to maintain all systems. Without the support of the manufacturer these systems are expected to be replaced from about 2003 at the rate of 5 systems per year.

VF Protection Intertrip Systems

There are two main types of Voice Frequency Protection Intertrip Systems in use on TransGrid's network, Fuji VF Intertrip Systems and Dewar VF Intertrip Systems.

The Fuji VF systems were manufactured prior to 1987 and are no longer supported by the supplier.

Dewar VF Intertrip Systems have replaced Fuji System over the past 5 years. A replacement program for the 16 Fuji TFCRE1 systems has been developed and will be complete by 2003 at a cost of $200,000.

At present there is no evidence that existing Fuji VF Intertrip systems will experience failures and there is adequate spares to maintain all systems. Without the support of the manufacturer these systems are expected to be replaced from about 2004 – 2020 at the rate of 20 systems per year, which will cost approximately $200,000 per year.

Dewar VF systems are currently supported by the manufacturer with an expected life of 25 years. These systems are expected to be replaced from about 2020 – 2025 at the rate of 6 systems per year.

Telephone Equipment

The telephone network was installed in two parts. In 1990-1992 the major sites were completed and in 1994 exchanges in the 330kv substations were installed. Ericsson manufactured the entire network with software upgrades to selected sites occurring in the late 1990's.

The large network requires constant maintenance to achieve a reliable system performance.

The manufacturer no longer supports the software versions that enable the exchanges to function and an evaluation has determined that a system software upgrade to BC10 is the most effective action. This uograde will take place in FY 2001/02.

Microwave Radio Network

The Microwave Network provides the major backbones for all communication systems owned by TransGrid. Under current projects the three main systems Western, Southern, and Northern are being replaced with an Optic Fibre (OPGW) Network. The remaining spur Microwave Systems will provide the communication bearers to substations and outlying centres.

There are five types of digital spur systems

AWA	6 ends.	No longer supported by the manufacturer, minimal spares, 1.5 to 2Ghz band
NEC500	4 ends.	Minimal spares, no manufacturer support and outdated technology.
NEC 600	6 ends.	spares, no manufacturer support and limited bandwidth.
SAIE	2 ends.	Minimal spares and manufacturer support
Harris Farinon	2 ends.	Adequate spares but no manufacturer support
Seimens	2 ends.	Adequate spares and manufacturer support

Optic Fibre Network

TransGrid has three major overhead earth wire optic fibre projects in progress. These projects when complete will provide all major backbone communication bearers. These will replace existing microwave backbone networks from Wallgrove to the Victorian boarder (Southern System), Wallgrove to Mt Piper (Western System) and Wallgrove to Dumaresq (Northern System).

This equipment is to be purchased and installed by December 2001. The expected life of the equipment is 20 to 25 years. This life cycle is determined by technological changes.

VHF Radio Network

TransGrid's Radio network consists of fixed repeaters and links, and a mobile fleet installed in vehicles or as desk stations.

The fixed repeaters and links consist of

1. Philips 814 Tranceivers. This equipment was manufactured in the early 1980s and is no longer supported by the manufacturer. Current spares are at minimal levels and will be depleted by 2002.
2. Midland Tranceivers. This equipment was manufactured in 1997 and is supported by Exicom and is expected to provide service till the year 2020.

The mobile fleet and desk base stations are Tait 2000 series transceivers. This equipment was manufactured in the early 1990s is supported by Tait. Current spares are adequate to continue services till 2015.

The Philips FM814s will be replaced progressively with TAIT 2000 series equipment, commencing in 2001 and proceding at the rate of 10 per year.

Repeater site ancillary equipment

TransGrid's repeater sites require ancillary equipment to provide site services.

These services are

- Batteries: Batteries at each site have a life of approximately 20 years and are replaced as and when required.
- Battery Chargers: Chargers at each site range between 12v, 24v or 50v. They have a life of approximately 30 years and are replaced as and when required.
- Air Conditioners: Air Conditioners at each site are either wall mount or split unit. These units run continuous for 24 hours a day. The life cycle is 5 to 10 years determined by location. They are replaced as and when required.
- Aerial Feeders and Antennae: Feeders and antennae provide transmission medium for Microwave and VHF services. The life cycle is 10 to 20 years determined by location. They are replaced as and when required or when systems are replaced.
- Cabling: Cabling consists of power, alarm and service wiring. Location and possible rodent damage determine the cabling life cycle. They are replaced as and when required

SCADA Outstations

TransGrid's current DAC outstations provide the local interface at each substation to the SCADA network. These outstations are not being replaced under the ABB SCADA replacement contract.

The outstations were manufactured in the early 1980s and are approximately 20 years old. The manufacturer no longer supports this equipment. Sufficient spare cards exist but individual components are no longer manufactured.

There are 46 TransGrid Toshiba outstations, 21 TransGrid MITS outstations, 19 Customer Toshiba outstations and 3 Customer MITS outstations. All of these outstations will be replaced over the next 5 year at the rate of 15 per year, after an initial trial to confirm the process and materials..

Communications with Snowy

The Snowy and TransGrid microwave networks are interconnected at Cabramurra. Improved communications links will be required when TransGrid assumes responsibility for operations of these assets. Mobile radio coverage will also need to be enhanced to improve marginal coverage near Upper and Lower Tumut.

Snowy Power Line Carrier

Existing Snowy Power Line Carrier (PLC) equipment for both protection and communications purposes is based on valve technology. Spare parts are no longer obtainable and the system requires replacement. Line Trap and secondary-coupling equipment is also being considered for replacement.

7. Environmental Strategies

TransGrid's Environmental Plan describes the elements of its Environmental Management System and the Business Units responsible for those elements, while TransGrid's Environmental Manual describes the procedures and practices involved.

Environmental Aspects of Substations

Substations may impact on the environment through their visual appearance, noise emission or escape of oil.

Native trees and shrubs are planted around substations, to promote native species and reduce the visual impact of substations.

Noise emissions from transformers are reduced by construction of suitable enclosures or walls where necessary. A program for replacing air-blast circuit breakers with quieter SF6 circuit breakers is in place.

TransGrid substations are designed and sited to minimise their impact on the environment. All sites have environmental response systems designed to ensure that, in the event of equipment failure, the surrounding environment is unaffected. Major oil-filled plant, such as transformers, is located within bunds. Secondary, and on some sites tertiary oil containment systems are installed, to prevent the escape of oil from the substation to the surrounding environment.

Environmental Aspects of Transmission Lines

Before construction of a new transmission line, extensive community consultation takes place.

An environmental impact statement is prepared, which assesses all the known possible environmental impacts of the construction and the operation of the line following construction. The statement is publicly exhibited and submissions from interested parties are encouraged. A program for managing construction and maintenance of the line following construction is then implemented, based on the findings of the Environmental Impact Statement and submissions received.

Procedures for maintenance of transmission line easements have been developed with the aim of minimising environmental impacts. Low growing native shrubs and trees are encouraged on easements.

A database is used to assist with easement maintenance. It contains all relevant environmental information about each easement, including the location of rare and threatened flora and fauna species and habitats, protected lands and rivers, archaeological relics, heritage sites and property owner requirements.

Environmental Initiatives

TransGrid is involved in a number of environmental projects.

TransGrid sponsors nine shade-houses throughout NSW, as part of Rotary's "Trees for 2000" program. Local school children raise native seedling in the shade-houses. Landcare groups plant the seedling in places needing vegetation.

TransGrid is also providing sponsorship for Greening Australia's "Corridors of Green" and "Greengird" projects. TransGrid's contribution has helped provide 1,000 trees for planting by school children along the Barton Highway between Yass and Canberra. Property owners, local Landcare and community groups in Yass area are involved in the "Greengrid" project, planting trees and shrubs to enhance the local environment and augment the habitat of the Superb Parrot.

The Illawarra Greenhood Orchid, Pterostylis gibbosa, is a rare and endangered species of plant, found near Lake Illawarra. TransGrid, together with the National Parks and Wildlife Service, the University of Wollongong and the Wollongong Native Orchid Society, is protecting and preserving the Orchid and its habitat.

TransGrid is the sponsor of the Kooragang Wetlands Rehabilitation Project, in the Newcastle area. A new visitors centre shows the importance of Coastal Wetlands to the local environment.

TransGrid has joined the Greenhouse Challenge, a joint initiative developed by industry and the Federal Government, to encourage organisations to reduce emission of greenhouse gasses. TransGrid has identified a number initiatives that will be undertaken as part of the program, including reducing usage of paper products, minimising energy use where possible and promoting tree-planting. A co-operative agreement will detail TransGrid's commitment to implementing the initiative. Each year, TransGrid will report its progress to the Australian Greenhouse Office.

4.4 Asset Disposal Strategies

4.4.1 Introduction

Assets are of value to TransGrid only in so much as they continue to cost effectively support the delivery of the required service. Once these assets no longer provide the required level of service their worth lies only in the benefits to be gained from their disposal.

Asset disposal is therefore the final stage in the asset life cycle and its proper planning and management is an integral part of TransGrid's Network Management Plan.

TransGrid's Asset Disposal Strategies mainly encompass two broad types of assets. The first involves real property holdings and the second involves general assets such as buildings, structures, plant and equipment.

Although real property assets normally have high values and their disposal often involves more complex planning and financial issues, the general disposal processes followed within TransGrid are very similar to the disposal of all other types assets. Therefore this Section of the Asset Management Plan outlines these general disposal strategies.

4.4.2 Asset Disposal Planning

TransGrid's Asset Disposal Planning involves a detailed assessment of those assets identified in the Planning/Capital Investment Strategies and Asset Management Strategies that are no longer required, or no longer effectively meet their service delivery outputs at the lowest long term cost to TransGrid. This allows TransGrid to cull redundant assets that might otherwise reduce efficient and effective service delivery.

Disposal planning incorporates two separate elements:

- the detailed assessment of assets identified as surplus, and
- the analysis and implementation of the physical Disposal of the assets.

An asset is identified as surplus when one of the following occurs:

- the asset is not required for the delivery of service, either currently or over the longer planning time frame,
- the asset becomes uneconomical to maintain or operate which could be due advances in technology, social expectations, changing demographic patterns or the economies of scale made possible by new service capacity,
- the asset wears out or becomes uneconomical to repair or refurbish.

Once an asset is identified as surplus, its physical disposal will depend on one or more of the following:

- whether or not there are net disposal benefits to TransGrid, either in financial or other terms such as management, supervision and storage,
- whether or not there are secondary (non core) service obligations associated with the asset which dictate its retention, for example heritage, open space or other social environmental considerations,
- whether or not disposal can be carried out without adverse impacts on the physical environment,
- compliance with any Legislative requirements such as for Asbestos and Polychlorinated Biphenyls (PCBs),
- whenever considered likely that some under-utilised or surplus assets may be of significant value to other agencies such as NSW Electrical Distributors, such agencies are advised of the asset's availability.

4.4.3 Asset Disposal Strategy Process

TransGrid's Asset Disposal Strategy Process is a structured and systematic process aimed at ensuring the asset portfolio comprises only of assets that effectively meet their service delivery requirements at the lowest long term cost. The processes involved are therefore directly linked with TransGrid's Service Delivery Strategies, TransGrid's Planning/Capital Investment Strategies and TransGrid's Asset Management Strategies.

The Disposal Strategy has five discrete stages, the main aspects of which as are follows:

Stage 1 - Assess in detail those assets identified by the Planning/Capital Investment and Asset Management Strategies as being Surplus to service delivery requirements.

Stage 2 - Assess the advantages or otherwise to TransGrid, TransGrid's Shareholders or the Community in divesting the Surplus assets.

Stage 3 - Identify any opportunities for increasing asset value.

Stage 4 - Identify related disposal requirements (auction, tender, private treaty or scrap) and processes including probity requirements.

Stage 5 - Prepare and implement appropriate Disposal Plan that satisfies all safety and environmental requirements.

The majority of TransGrid's aged Surplus assets are normally scrapped or sold for material salvage and depending on the materials used in the design and construction of the assets a number of procedures have been established to facilitate this process. Many of these processes are contained within TransGrid's Waste Management standard.

4.4.4 Waste Management

TransGrid's waste management procedures have been established in accordance with both NSW and Australian legislation requirements including the NSW Protection of the Environment (Operations) Act 1997 and the Waste Minimisation and Management Act, 1995. This involves the appropriate disposal methods for various waste and materials, the licensing of TransGrid sites and facilities and direct dealings with the Environmental Protection Authority.

Within TransGrid, specific asset disposal strategies concerning certain types of materials include the following:

Disposal of Polychlorinated Biphenyls (PCB),

The NSW PCB Chemical Control Order 1997 requires that:

i) Owners of PCB contaminated materials must carry out a survey by 1st January 1999 to identify items of equipment and articles containing PCB. TransGrid has basically completed this task.

ii) Concentrated PCB material (i.e. PCB greater than 10%) must be removed from priority areas within 2 years of completing the survey, and from other than priority areas within 5 years of completing the survey. TransGrid completed the removal and destruction of all concentrated PCB materials (1,155 tonnes) by January 1999 at a cost of $5.7M.

iii) Scheduled PCB material (i.e. PCB greater than 50 ppm) must be removed from service, or processed in-situ to reduce the PCB concentration below 50 ppm, within 5 years of identification. For TransGrid, this requires that scheduled PCBs must be either removed from service or processed by 2004 and strategies are in place to replace meet this requirement.

iv) Non-scheduled PCB materials (i.e. PCB less than 50 ppm) are not required to be removed from service within any legislative time-frame, however once removed from service appropriate disposal methods are required. Since 1999 TransGrid has disposed of 211 tonnes of non-scheduled material at a cost of $626,000

Disposal of Chemical Fluid Dow C4

One of the Non-PCB fluids introduced for Power Capacitors in 1980 was the chemical "Dow C4" and within TransGrid 24 capacitor banks contain this fluid (total of 985MVAr). This fluid requires special precautions for safe handling and paper disposal. Hence significant expenditure is being incurred at the moment to dispose of any failed Dow C4 capacitors.

However, from approximately 2010 a number of these Dow C4 filled capacitor banks will be approaching the end of their expected life span. A Disposal Strategy will need to be developed as the replacement program could take up to ten years to complete and require significant resources. This aspect does not impact on the period of this Plan.

Disposal of Batteries

TransGrid has quantities of large station and communication batteries that comprise of Lead Acid or Ni-Cad. These batteries have a normal life span of approximately 20 years and their retirement is determined by the Maintenance Battery Policy and Battery Maintenance Procedures.

Disposal of Ni-Cad and Lead Acid batteries is a requirement of TransGrid's Procurement Specification for Batteries and thus forms part of the contract. The old Ni-Cad cells are returned to Australian manufacturer's works for shipment overseas for recycling while the Lead Acid units are recycled within Australia. The whole operation is carried out in accordance with the relevant dangerous goods and environmental regulations.

Appendices

Appendices

A Corporate Policies

Health and Safety

Environment

Total Quality

B Asset Inventory

Substations and Switching Stations

Transformers and Circuit Breakers

Transmission Lines/Underground Cables

C Resource Plans

Capital Expenditure Summary

Major Operating Projects Expenditure Summary (Refurbishment/Replacement)

Appendix A - Corporate Policies

Health and Safety Policy

TransGrid is committed to a goal of zero injuries, occupational illnesses and incidents.
TransGrid believes that all accidents are preventable on and off the job.

This commitment will be achieved by honouring the following principles:

- Safety is our first priority
- We will not budget for injuries
- Working safely is a condition of employment
- No shortcuts when it comes to safety
- Management and Team Leaders demonstrate leadership in health and safety
- Employees and contractors take ownership of safety by not accepting unsafe behaviour from anyone

Demonstration of our on-going commitment to the health and safety of employees, contractors and visitors is through compliance with and external certification to AS 4801. TransGrid will consult with elected employee health and safety representatives and employees in any workplace change that will affect the health and safety of employees, and to ensure continuous improvement in all areas of our work.

RESPONSIBILITY: TransGrid's Board and Executive are ultimately accountable and responsible for the Health and Safety of employees, visitors, contractors and the public, and for legislative OHS compliance. In particular, the following responsibilities apply:

Managers are responsible for:

- Provision and maintenance of a safe workplace
- Provision of written procedures and instructions to ensure safe systems of work
- Establishing objectives and targets to ensure continual improvement aimed at eliminating injury and illness
- Provision of resources to effectively meet the Health and Safety Commitment
- Compliance with legislative requirements and current industry standards

Team Leaders are responsible for:

- Provision of information, training and supervision to ensure employees and contractors are able to carry out their work safely
- Implementation of relevant actions from their business unit Health and Safety Plan to meet agreed performance targets

Employees are responsible for:

- Ensuring their own safety and the safety of others in the workplace by following defined occupational health and safety policies and procedures and avoiding "at risk" behaviour in all activities
- Working with Management to prevent injury and illness
- Reporting all accidents, incidents and potential hazardous conditions to their Team
- Leader immediately they become aware of them.

GD HS G1 001

Environment Policy

The Protection of our environment is one of the fundamental values associated with all TransGrid activities. The TransGrid Environmental Policy applies to both the natural environment and items of Environmental Heritage. This includes those buildings, works, relics or places of historical, scientific, cultural, social, archeological, natural or aesthetic significance.

The policy applies to the design, siting, construction, maintenance, operation, decommissioning and disposal of all buildings, plant and equipment, including transmission lines and cable easements.

TransGrid cares for the environment by:

- Complying with all relevant environmental statutes, regulations and standards;
- Operating an environmental management system to prepare and document environmental procedures and to supervise and review their effective implementation; and
- Ensuring that environmental protection factors are taken into account for each activity.

TransGrid teams:

- Take active measures to protect the environment during all work activities;
- Consult with appropriate community organisations and government departments; and
- Are trained and regularly updated on environmental issues relating to their particular work requirements.

Protection of the environment is the responsibility of all TransGrid staff. TransGrid will continually improve environmental performance through the setting of targets and regular environmental auditing.

Total Quality Policy

TransGrid's objectives are to provide a safe, reliable, environmentally effective and economic bulk electricity network service to our customers and the community. To achieve these objectives we will:

- Apply best practice quality management principles throughout the organisation
- Improve the skills and practices of organisational work teams to enhance safety, productivity and job satisfaction and provide an environment in which all staff can actively participate in the delivery of product and service excellence.
- Develop integrated systems that contribute to the effectiveness and efficiency of our business activities.
- Develop mutually beneficial relationships with suppliers to reduce costs and improve performance standards.

Leadership at all levels is critical to our success; as is the fundamental concept of continual improvement in all products, processes and systems.

Demonstration of our on-going commitment to quality is through compliance with, and external certification to ISO9001.

GD QA G1 002 Revision 2

Appendix B - Asset Inventory

Schedule of Substations and Switching Stations

	Comm Year	System Voltage kV
500 kV Voltage - Sites		
Eraring	1984	500/330
Kemps Creek	1984	500/330
	1989	330/16
Total Sites at 500kV = 2		

	Comm Year	System Voltage kV
330 kV Voltage - Sites		
Armidale	1972	330/132
	1969	132/66
Avon	1974	330
Bayswater	1984	330
Beaconsfield West	1979	330/132
Canberra	1967	330/132
Dapto	1962	330/132
Darlington Point	1988	330/220
		330/132
Dumaresq	2000	330
Ingleburn	1984	330/66
Jindera	1979	330/132
Kangaroo Valley	1976	330
Liddell	1970	330
Lismore	1992	330/132
Liverpool	1985	330/132
Mt Piper	1986	330
Marulan	1992	330/132
Munmorah	1967	330
Muswellbrook	1983	330/132
Newcastle	1969	330/132
Regentville	1997	330/132
Sydney East	1976	330/132
Sydney North	1963	330/132
Sydney South	1961	330/132
Sydney West	1965	330/132
Tamworth	1968	330
Tomago	1983	330/132
Tuggerah	1986	330/132
Vales Point	1962	330/132
Vineyard	1994	330/132
Wagga	1973	330/132
Wallerawang	1975	330/132
Wellington	1984	330/132
Yass	1959	330/132
	1965	132/66
Total Sites at 330 kV = 33		

	Comm Year	System Voltage kV
220 kV Voltage - Sites		
Balranald	2001	220/22
Broken Hill	1979	220/22
Buronga	1988	220
Total Sites at 220kV = 3		

	Comm Year	System Voltage kV
132 kV Voltage - Sites		
Albury	1958	132
A.N.M.	1981	132
Beryl	1976	132/66
Burrinjuck	1950	132
Coffs Harbour	1979	132/66
Coleambally	1993	132
Cooma	1954	132/66/11
Cowra	1960	132/66
Deniliquin	1971	132/66
Finley	1991	132/66
Forbes	1969	132/66
Gadara	2000	132/11
Glenn Innes	1970	132/66
Griffith	1964	132/33
Gunnedah	1985	132/66
Hume	1957	132
Inverell	1984	132/66
Kempsey	1967	132/33
	66/33	
Koolkhan	1963	132/66
Molong	2001	132/66
Moree	1984	132/66
Mt Piper	1988	132/66
Munyang	1989	132/33
Murrumburrah	1985	132/66
Narrabri	1965	132/66
Orange	1954	132/66
Panorama	1979	132/66
Parkes	1993	132/66
Port Macquarie	1979	132/33
Queanbeyan	1957	132/66
Tamworth	1961	132/66
Taree	1958	132/66/33
Tenterfield	1970	132/22
Tumut	1967	132/66
Wagga	1955	132/66
Wallerawang	1953	132/66
Waratah West	1992	132
Yanco	1969	132/33
	1965	66/33
Total Sites at 132 kV = 38		
Total Sites at all voltages = 76		

Transgrid System Transformers

Substation	Volts	MVA	Phases	Manufacturer	Contract	Date	Qty
Armidale	330	150	3	Jeum/Schneider	1517/1	1969	2
Armidale	330	150	3	Parson Peebles	1517/2	1969	1
Armidale	132	30	3	Leper	1554	1966	2
Balranald	220	30	3	ABB	1023	2001	1
Beaconsfield	330	375	3	Tyree	2520	1979	2
Beryl	132	120	3	Tyree	2976/4	1983	2
Broken Hill	220	100	3	Tyree	2770	1979	2
Canberra	330	133	1	Tyree	3529	1987	1
Deniliquin	132	60	3	Tyree	3735/1	1989	2
Eraring	500	400	1	Fuji	3004	1982	4
Coffs Harbour	132	60	3	Tyree	2686/1	1978	2
Cooma	132	27.5	3	Bre	XRLY	1959	2
Cooma	132	60	3	Tyree	2105	1976	1
Cowra	132	30	3	Acec	724/1	1969	2
Dapto	330	160	3	Hitachi	974	1962	1
Dapto	330	375	3	Tyree	2520	1979	1
Dapto	330	375	3	Tyree	2875/2	1982	2
Darlington Pt	330	200	3	Tyree	2875/2	1983	1
Darlington Pt	330	280	3	Tyree	3631	1988	3
Finley	132	30	3	English Elect	724/2	1961	1
Forbes	132	60	3	Tyree	1670	1969	2
Gadara	132	30	3	ABB	XVISY	2000	1
Glen Innes	132	30	3	Elin	262-1/23	1956	1
Glen Innes	132	30	3	ACEC	724/1	1959	1
Griffith	132	45	3	ACEC	209	1964	3
Gunnedah	132	60	3	Tyree	3485	1985	2
Ingleburn	330	250	3	Tyree	2875/1	1983	2
Inverell	132	120	3	Tyree	2976/6	1983	2
JIndera	330	375	3	Tyree	2520	1981	1
Jindera	330	375	3	Tyree	2875/2	1981	1
Kempsey	132	30	3	English Elect	1561	1966	2
Kempsey	66	15	3	English Elect	772	1959	2
Kemps Creek	330	150	3	ABB	3800	1991	2
Kemps Creek	500	400	1	Fuji	3004	1983	7
Koolkhan	132	30	3	English Elect	724/2	1961	1
Koolkhan	132	30	3	English Elect	807/1	1960	1
Kemps Creek	500	400	1	Fuji	3004	1983	7
Koolkhan	132	30	3	English Elect	724/2	1961	1
Koolkhan	132	30	3	English Elect	807/1	1960	1
Lismore	330	375	3	ABB	4005/1A	1992	2
Liverpool	330	375	3	Tyree	3529	1985	2
Mt Piper	330	375	3	Tyree	3631/1	1989	1
Mt Piper	132	120	3	Tyree	2976/7	1984	2
Marulan	330	160	3	Hitachi	974	1962	1
Molong	132	30	3	English Elect	724/2	1961	1
Moree	132	60	3	Tyree	2976/2	1983	2
Munyang	132	30	3	ACEC	60/2	1955	2
Murrumburra	132	60	3	Tyree	3485	1984	2
Muswellbrook	330	375	3	Tyree	2875/2	1983	2
Narrabri	132	30	3	AEI	1393A	1965	2
Narrabri	132	30	3	ELIN	E60	1955	1
Newcastle	330	125	1	GEC	1497	1969	2

Substation	Volts	MVA	Phases	Manufacturer	Contract	Date	Qty
Newcastle	330	133	1	Mitsubishi	1712	1969	10
Orange	132	30	3	English Elect	1229RB	1952	3
Panorama	132	120	3	Tyree	2976/3	1981	2
Parkes	132	60	3	ABB	3999/2	1993	1
Pt Macquarie	132	30	3	Hackbridge	1246/4	1954	3
Queanbeyan	132	30	3	ACEC	724/1	1966	1
Queanbeyan	132	30	3	ELIN	262-1/23	1964	2
Regentville	330	375	3	Tyree	2875	1984	1
Regentville	330	375	3	ABB	4005	1994	1
Sydney East	330	133	1	Tyree	2231	1974	10
Sydney North	330	375	3	Tyree	2875	1980	1
Sydney North	330	375	3	Tyree	2875/2	1981	3
Sydney South	330	87	1	AEI	1195	1964	3
Sydney South	330	87	1	Savigliano	1565	1968	5
Sydney South	330	87	1	Toshiba	891	1961	1
Sydney South	330	87	1	Tyree	1999/2	1971	3
Sydney West	330	125	1	Ferranti	1533	1968	3
Sydney West	330	125	1	Mitsubishi	1016/2	1963	6
Sydney West	330	125	1	Tyree	1999/3	1972	2
Tamworth	330	150	3	Parson Peebles	1517/2	1968	2
Tamworth	330	200	3	ABB	1016	2000	1
Tamworth	132	60	3	Tyree	1670	1969	2
Tamworth	132	60	3	Tyree	2105	1971	1
Taree	132	30	3	English Elect	1229RA/1	1958	1
Taree	132	30	3	English Elect	1561	1966	1
Taree	132	60	3	Tyree	3666/1	1988	2
Tenterfield	132	15	3	English Elect	1849	1970	2
Tuggerah	330	375	3	Tyree	2875/2	1982	1
Tumut	132	30	3	Leper	1554	1967	1
Tumut	132	60	3	Tyree	3485	1989	1
Vales Point	330	160	3	Hitachi	974	1962	2
Vineyard	330	200	3	ABB	4005	1995	1
Vineyard	330	200	3	ABB	1016	2000	1
Wagga	330	133	1	Tyree	2184	1973	6
Wagga	132	60	3	Tyree	1670	1968	1
Wagga	132	60	3	Tyree	2105	1975	1
Wagga	132	60	3	Tyree	3735	1991	1
Wallerawang	132	60	3	GEC	2179	1971	2
Wallerawang	330	215	3	Parsons	2091/1	1974	2
Wellington	330	200	3	ABB	4381	1996	1
Wellington	330	190	3	Tyree	1760/2	1983	1
Yanco	132	45	3	Hackbridge	1419/1	1969	2
Yanco	66	7.5	3	Tyree	984	1965	1
Yass	330	54	1	English Elect	449	1959	7
Yass	132	30	3	ELIN	262-1/23	1962	1

Circuit Breakers

Type	Manufacturer	Type	Voltage (kV)	Quantity	First Install date	Last Install Date
Small Oil	ASEA	HKEYC120/600	132	28	1957	1958
	ASEA	HKEYC120/800	132	4	1959	1959
	ASEA	HKEY60/600	66	13	1960	1960
	ASEA	HLC72.5 1600	66	62	1978	1982
	ASEA	HLD145/1200B	132	28	1972	1979
	ASEA	HLD145/1200A	132	20	1968	1970
	ASEA	HLD145/1250B	132	14	1976	1979
	ASEA	HLD145/1250C	132	10	1978	1981
	ASEA	HLR145/2501E	132	73	1980	1989
	ASEA	HLR145/2502B	132	2	1980	1980
	ASEA	HLR145/3152C	132	25	1980	1984
	ASEA	HLR170/2502	132	4	1972	1972
	ASEA	HLR84/2501B	66	16	1983	1983
	DELLE	HPGE 9/12/E	66	66	1973	1975
	Galileo	OCERD150	132	12	1961	1968
	Galileo	OCE60	66	10	1961	1965
	Magrini	38MGE1500	33	20	1978	1982
	Magrini	12MG500	11	3	1980	1981
	Oerlikon	TOF60.6	66	4	1957	1964
	Oerlikon	FR	132	10	1976	1977
	Reyrolle	132OS10	132	12	1954	1964
	Reyrolle	132OS14	132	8	1964	1968
	Reyrolle	132OS15	132	9	1958	1959
	Reyrolle	66OS2	66	3	1976	1976
	Reyrolle	14SPH	132	7	1959	1959
	SACE	RGE24-100	22	2	1978	1978
	SACE	RME24	22	4	1978	1978
	Sprecher	HPF515Q6F	330	7	1974	1976
	Sprecher	HPF515C6FS	330	13	1976	1981
	Sprecher	HPF509K	66	2	1978	1978
	Sprecher	HPF512N/2FS	132	4	1980	1980
	Stand Way	S250	11	3	1977	1977
			Total	498		

Type	Manufacturer	Type	Voltage (kV)	Quantity	First Install date	Last Install Date
Air Blast	ASEA	HTB20/2500D	11	5	1963	1964
	AEI	GA11W8	330	5	1958	1958
	AEG	WM5077/1	132	5	1960	1961
	BROWN BOV.	DBG2011	11	4	1958	1958
	MERLIN GERIN	PPTY77MH	132	12	1967	1968
	REYROLLE	OBR30	132	9	1963	1963
	REYROLLE	OBR60	330	9	1967	1970
			TOTAL	49		

Type	Manufacturer	Type	Voltage (kV)	Quantity	First Install date	Last Install Date
SF6	ABB	EDFSK1	66	25	1996	1997
	ABB	LTB145	132	64	1996	1997
	ABB	HPL145	132	25	1990	1996
	ABB	HPL170	132	2	1987	1992
	ABB	HPL245/25B1	220	12	1986	1988
	ABB	HPL362/31A2	330	40	1992	1997
	ALSTOM	0X36	33	5	2000	2000
	ALSTOM	FX22D/CIN	500	1	2000	2000
	BROWN BOV.	HB.24.16.25L	22	4	1986	1986
	BROWN BOV.	HB.36.12.25L	33	3	1988	1990
	BROWN BOV.	ELF72.5PC1AR	66	4	1985	1985
	BROWN BOV.	ELF72.5N1R	66	11	1981	1986
	BROWN BOV.	ECK132	132	17	1975	1978
	GEC	FXT15	330	77	1997	1997
	MAGRINI	24GI-E25	22	1	1988	1988
	MAGRINI	36GB20	33	2	1984	1984
	MAGRINI	36GIE	33	21	1996	1997
	MERLIN GERIN	PFA1	66	5	1986	1986
	MERLIN GERIN	FA1	132	15	1980	1986
	MERLIN GERIN	FA2	330	53	1980	1984
	MERLIN GERIN	FA4	500	11	1982	1983
	SIEMENS	3AQ2	330	40	1991	1993
	SIEMENS	3AS2	330	43	1982	1984
	SPRECHER	FXT9	66	6	1992	1993
	SPRECHER	HGF309	66	4	1986	1991
	SPRECHER	HGF112/1C	132	32	1986	1996
	SPRECHER	HGF312/1C	132	14	1992	1994
	SPRECHER	HGF215/2B	330	34	1986	1989
			TOTAL	566		

Type	Manufacturer	Type	Voltage (kV)	Quantity	First Install date	Last Install Date
Bulk Oil	AEI	LG1C/44	33	13	1966	1968
	BTH	OW407	66	8	1952	1953
	REYROLLE	LMT/X8/MO	11	3	1980	1980
	WESTINGHOUSE	345GC	33	39	1957	1976
			TOTAL	63		

Type	Manufacturer	Type	Voltage (kV)	Quantity	First Install date	Last Install Date
Vacuum	GEC	VAC	11	1	1989	1989
	JOSLYN	VBU-4	220	2	1978	1978
	SIEMENS	3AF1766	11	1	1993	1993
			TOTAL	4		

Transmission Lines and Underground Cables

Circuit No.	From (Site 1)	To (site 2)	Length (km)	Predominant Construction
Assets constructed at rated voltage: 500 kV				
In Service at 500 kV:				
5A1	ERARING	KEMPS CREEK	143.0	Double Circuit Steel Tower
5A1/1	ERARING	FIELD TERMINATED	2.5	Double Circuit Steel Tower
5A2	ERARING	KEMPS CREEK	143.0	Double Circuit Steel Tower
5A2/1	ERARING	FIELD TERMINATED	2.5	Double Circuit Steel Tower
In Service at 330 kV:				
35	MARULAN	MT.PIPER	161.0	Double Circuit Steel Tower
36	MARULAN	MT.PIPER	161.0	Double Circuit Steel Tower
73	BAYSWATER	MT.PIPER	225.7	Double Circuit Steel Tower
74	BAYSWATER	WALLERAWANG	236.0	Double Circuit Steel Tower
Assets constructed at rated voltage: 330 kV				
In Service at 330 kV:				
01	CANBERRA	UPPER TUMUT	99.9	Single Circuit Steel Tower
02	UPPER TUMUT.	YASS 330	149.0	Single Circuit Steel Tower
03	LOWER TUMUT	YASS 330	129.0	Single Circuit Steel Tower
4	MARULAN	YASS 330	114.0	Single Circuit Steel Tower
5	MARULAN	YASS 330	118.0	Single Circuit Steel Tower
6	CANBERRA	KANGAROO V	190.0	Single Circuit Steel Tower
07	CANBERRA	LOWER TUMUT	98.8	Single Circuit Steel Tower
8	DAPTO	MARULAN	76.4	Single Circuit Steel Tower
8C	ARMIDALE	DUMARESQ	172.0	Double Circuit Steel Tower
8E	ARMIDALE1	DUMARESQ	172.0	Double Circuit Steel Tower
9	CANBERRA	YASS 330	42.2	Single Circuit Steel Tower
10	AVON	DAPTO	10.9	Single Circuit Steel Tower
11	DAPTO	SYDNEY SOUTH	68.0	Single Circuit Steel Tower
12	LIVERPOOL	SYDNEY SOUTH	18.3	Double Circuit Steel Pole
13	KEMPS CREEK	SYDNEY SOUTH	24.1	Single Circuit Steel Tower
14	KEMPS CREEK	SYDNEY NORTH	49.8	Single Circuit Steel Tower
16	AVON	MARULAN	70.6	Single Circuit Steel Tower
18	DAPTO	KANGAROO V	42.7	Single Circuit Steel Tower
20	SYDNEY NORTH	SYDNEY WEST	33.2	Single Circuit Steel Tower
21/1	STERLAND	SYDNEY EAST	73.4	Single Circuit Steel Tower
21/2	MUNMORAH	STERLAND	26.5	Single Circuit Steel Tower
21/3	STERLAND	TUGGERAH	13.4	Single Circuit Steel Tower
22	SYDNEY NORTH	VALES PT.	86.1	Single Circuit Steel Tower
23	MUNMORAH	VALES PT.	7.2	Single Circuit Steel Tower
24	NEWCASTLE	VALES PT.	46.4	Single Circuit Steel Tower
25	ERARING	VINEYARD	109.0	Double Circuit Steel Tower
25/1	ERARING	FIELD TERMINATED	2.5	Double Circuit Steel Tower
26	MUNMORAH	SYDNEY WEST	124.0	Double Circuit Steel Tower
27	SYDNEY EAST	SYDNEY NORTH	21.9	Single Circuit Steel Tower
28	SYDNEY EAST	SYDNEY NORTH	22.3	Single Circuit Steel Tower
29	SYDNEY WEST	VINEYARD	20.7	Double Circuit Steel Tower
30	LIVERPOOL	SYDNEY WEST	16.6	Single Circuit Steel Tower
31	BAYSWATER	REGENTVILLE	171.0	Double Circuit Steel Tower
32	BAYSWATER	SYDNEY WEST	189.0	Double Circuit Steel Tower
33	BAYSWATER	LIDDELL	6.0	Double Circuit Steel Tower
34	BAYSWATER	LIDDELL	6.0	Double Circuit Steel Tower
35	MARULAN	MT PIPER	0.6	Double Circuit Steel Tower

Circuit No.	From (Site 1)	To (site 2)	Length (km)	Predominant Construction
In Service at 330 kV (Contd):				
36	MARULAN	MT PIPER	0.58	Double Circuit Steel Tower
37	AVON	KEMPS	64.3	Single Circuit Steel Tower
38	REGENTVILLE	SYDNEY WEST	17.5	Double Circuit Steel Tower
39	SYDNEY WEST	YASS 330	238.0	Single Circuit Steel Tower
41	BEACONSFIELD	SYDNEY SOUTH	19.7	Underground Cable
051	LOWER TUMUT	WAGGA 330	100.0	Single Circuit Steel Tower
060	JINDERA	WODONGA TS	42.4	Single Circuit Steel Tower
62	JINDERA	WAGGA 330	99.6	Single Circuit Steel Tower
63	DARLINGTON PT.	WAGGA 330	152.0	Single Circuit Steel Tower
71	MT.PIPER	WALLERAWANG	7.9	Double Circuit Steel Tower
72	MT.PIPER	WELLINGTON 330	171.0	Single Circuit Steel Tower
73	BAYSWATER	MT PIPER	1.42	Single Circuit Steel Tower
74	BAYSWATER	WALLERAWANG	1.9	Double Circuit Steel Tower
76	SYDNEY SOUTH	WALLERAWANG	143.0	Double Circuit Steel Tower
77	INGLEBURN	WALLERAWANG	121.0	Double Circuit Steel Tower
78	INGLEBURN	SYDNEY SOUTH	21.1	Double Circuit Steel Tower
81	LIDDELL	NEWCASTLE	101.0	Single Circuit Steel Tower
82	LIDDELL	TOMAGO 330	115.0	Single Circuit Steel Tower
83	LIDDELL	MUSWELLBROOK	17.7	Single Circuit Steel Tower
84	LIDDELL	TAMWORTH 330	139.0	Single Circuit Steel Tower
85	ARMIDALE	TAMWORTH 330	104.0	Single Circuit Steel Tower
86	ARMIDALE	TAMWORTH 330	111.0	Single Circuit Wood Pole
88	MUSWELLBROOK	TAMWORTH 330	127.0	Single Circuit Steel Tower
89	ARMIDALE	LISMORE	304.7	Single Circuit Steel Tower
90	ERARING	FIELD TERM	2.46	Double Circuit Steel Tower
91	ERARING	FIELD TERM	2.46	Single Circuit Steel Tower
92	NEWCASTLE	VALES PT.	35.9	Double Circuit Steel Tower
93	ERARING	NEWCASTLE	20.7	Double Circuit Steel Tower
93/1	ERARING	FIELD TERMINATED	2.5	Double Circuit Steel Tower
94	NEWCASTLE	TOMAGO 330	24.3	Double Circuit Steel Tower
95N/1	FIELD TERMINATED	WARATAH WEST	0.2	Double Circuit Steel Tower
95W	NEWCASTLE	TOMAGO 330	25.4	Double Circuit Steel Tower
95W/4	FIELD TERMINATED	WARATAH WEST	1.5	Double Circuit Steel Tower
In Service at 132 kV:				
250	MT.COLAH	SYDNEY NORTH	8.6	Double Circuit Steel Tower
92Z/1	MT.COLAH	SYDNEY EAST	12.6	Double Circuit Steel Tower
92Z/2	MT.COLAH	SYDNEY NORTH	11.2	Double Circuit Steel Tower
932/2	MT.DRUITT	SYDNEY WEST	7.3	Double Circuit Steel Tower
939/2	MT.DRUITT	SYDNEY WEST	7.3	Double Circuit Steel Tower
947	TEE B	MT PIPER	23.8	
959	SYDNEY EAST	SYDNEY NORTH	23.7	Double Circuit Steel Tower
95N	NEWCASTLE	WARATAH WEST	18.3	Double Circuit Steel Tower
95W/2	KILLINGWORTH	TOMAGO 330	25.4	Double Circuit Steel Tower
95W/3	TOMAGO 330	WARATAH WEST	8.1	Double Circuit Steel Tower

Assets constructed at rated voltage: 220 kV

In Service at 220 kV:				
0X1	BURONGA	RED CLIFFS	23.9	Single Circuit Steel Tower
X2	BROKEN HILL	BURONGA SS	259.0	Single Circuit Steel Tower
X5	BURONGA	DARLINGTON PT.	398.0	Single Circuit Steel Tower

Circuit No.	From (Site 1)	To (site 2)	Length (km)	Predominant Construction
Assets constructed at rated voltage: 132 kV				
In Service at 132 kV:				
0979	GUTHEGA	MUNYANG	0.5	Single Circuit Wood Pole
097B	BLOWERING	TUMUT 132	13.3	Single Circuit Wood Pole
944	ORANGE	WALLERAWANG	98.3	Single Circuit Wood Pole
945/1	945 TEE	ORANGE	88.9	Single Circuit Wood Pole
945/2	945 TEE	WELLINGTON 330	6.2	Single Circuit Wood Pole
947	947 TEE B	MT.PIPER132	92.8	Single Circuit Wood Pole
947/2	947 TEE	WELLINGTON 330	19.0	Single Circuit Wood Pole
947/3	947 TEE	947 TEE B	67.8	Single Circuit Wood Pole
947/4	947 TEE B	ORANGE	3.0	Double Circuit Concrete Pole
948	ORANGE	PANORAMA	44.8	Single Circuit Wood Pole
94B	BERYL	WELLINGTON 330	52.2	Single Circuit Wood Pole
94E	MT.PIPER132	WALLERAWANG 132	9.0	Single Circuit Wood Pole
94K	PARKES 132	WELLINGTON 330	117.0	Single Circuit Wood Pole
94M	94M TEE B	BERYL	29.6	Single Circuit Wood Pole
94M/1	944 TEE A	94M TEE B	52.2	Single Circuit Wood Pole
94M/2	94M TEE A	MT.PIPER132	42.7	Single Circuit Wood Pole
94T	MOLONG	ORANGE	31.3	Single Circuit Wood Pole
94U	FORBES 132	PARKES 132	30.3	Single Circuit Wood Pole
94X	PANORAMA	WALLERAWANG 132	57.5	Single Circuit Wood Pole
94Y	MT.PIPER	MT.PIPER 132	1.8	Single Circuit Wood Pole
95N	NEWCASTLE	WARATAH WEST	18.6	Double Circuit Steel Tower
962/2	962 TEE	WARATAH WEST	1.6	Double Circuit Steel Tower
963/1	TAREE	TEA GARDENS	81.9	Single Circuit Wood Pole
963/2	963 JUNCTION	TEA GARDENS	23.7	Single Circuit Wood Pole
964	PT. MACQUARIE	TAREE	66.0	Single Circuit Wood Pole
965	ARMIDALE	KEMPSEY	139.0	Single Circuit Wood Pole
966	ARMIDALE	KOOLKHAN	177.0	Single Circuit Wood Pole
967	KOOLKHAN	LISMORE 330	90.2	Single Circuit Wood Pole
968	NARRABRI 132	TAMWORTH 132	177.0	Single Circuit Wood Pole
969	GUNNEDAH	TAMWORTH 132	61.5	Single Circuit Wood Pole
96C/1	96C TEE	ARMIDALE	99.8	Single Circuit Wood Pole
96C/2	96C TEE	COFFS HBR.132	40.0	Single Circuit Wood Pole
96F/1	96F JUNCTION	96F TEE	30.7	Single Circuit Wood Pole
96F/2	96F TEE	TAREE	85.0	Single Circuit Wood Pole
96G	KEMPSEY	PT.MACQUARIE	43.1	Single Circuit Wood Pole
96H	COFFS HBR.132	KOOLKHAN	80.0	Single Circuit Wood Pole
96L	LISMORE	TENTERFIELD	125.4	Single Circuit Wood Pole
96M	MOREE	NARRABRI 132	107.0	Single Circuit Wood Pole
96N	ARMIDALE	INVERELL	111.0	Single Circuit Wood Pole
96T/1	96T TEE	ARMIDALE	96.0	Single Circuit Wood Pole
96T/2	96T TEE	GLEN INNES	0.2	Single Circuit Wood Pole
96T/3	96T TEE	TENTERFIELD	80.3	Single Circuit Wood Pole
96X	BHP ROD	WARATAH WEST	4.7	Double Circuit Steel Tower
96X/1	FIELD TERMINATED	WARATAH WEST	0.7	Double Circuit Steel Tower
96Y	BHP ROD	WARATAH WEST	4.6	Double Circuit Steel Tower
970	BURRINJUCK	YASS 330	37.3	Single Circuit Wood Pole
973	COWRA 132	YASS 330	119.0	Single Circuit Wood Pole
975	QUEANBEYAN	ROYALLA	32.8	Single Circuit Wood Pole
976/1	CANBERRA	QUEANBEYAN	57.6	Single Circuit Wood Pole
976/2	SPRING FLAT	YASS 330	37.0	Single Circuit Wood Pole
977/1	CANBERRA	QUEANBEYAN	57.6	Single Circuit Wood Pole
977/2	YASS	SPRING FLAT	36.1	Single Circuit Wood Pole
978/1	CANBERRA	ROYALLA	49.2	Double Circuit Steel Tower
978/2	COOMA	ROYALLA	73.4	Single Circuit Wood Pole

Circuit No.	From (Site 1)	To (site 2)	Length (km)	Predominant Construction
In Service at 132 kV (Contd):				
97A	TAMWORTH 132	TAMWORTH 330	3.0	Single Circuit Wood Pole
97B	TAMWORTH 132	TAMWORTH 330	3.0	Single Circuit Wood Pole
97D/1	CANBERRA	ROYALLA	49.2	Double Circuit Steel Tower
97D/2	COOMA	ROYALLA	79.6	Single Circuit Wood Pole
97K/1	COOMA	SNOWY ADIT	66.0	Single Circuit Wood Pole
97K/3	97K TEE	MUNYANG	0.4	Single Circuit Wood Pole
990	WAGGA 132	YASS 330	150.0	Single Circuit Wood Pole
991	MURRUMBURRAH	WAGGA 330	125.0	Single Circuit Wood Pole
992	BURRINJUCK	TUMUT 132	52.7	Single Circuit Wood Pole
993	TUMUT 132	WAGGA 330	85.8	Single Circuit Wood Pole
994	WAGGA 330	YANCO	128.0	Single Circuit Wood Pole
995	ALBURY	HUME P.S.	13.9	Single Circuit Wood Pole
996	A.N.M.	WAGGA 330	106.0	Single Circuit Wood Pole
998	COWRA 132	FORBES 132	88.2	Single Circuit Concrete Pole
999	COWRA 132	YASS 330	114.0	Single Circuit Steel Tower
99A/1	FINLEY 132	WAGGA 330	184.0	Single Circuit Wood Pole
99A/3	DENILIQUIN 132	FINLEY 132	46.6	Single Circuit Wood Pole
99B	ALBURY	JINDERA	17.0	Single Circuit Wood Pole
99D	DARLINGTON PT.	YANCO	37.4	Single Circuit Wood Pole
99F	WAGGA 330	YANCO	126.0	Single Circuit Wood Pole
99H	A.N.M.	JINDERA	11.5	Single Circuit Wood Pole
99J	GRIFFITH	YANCO	45.9	Single Circuit Wood Pole
99K	DARLINGTON PT.	GRIFFITH	59.7	Single Circuit Concrete Pole
99M	MURRUMBURRAH	YASS 330	71.9	Single Circuit Wood Pole
99P	GADARA	TUMUT	7.2	Single Circuit Concrete Pole
99T/1	COLEAMBALLY	DARLINGTON PT.	13.3	Single Circuit Concrete Pole
99T/3	COLEAMBALLY	DENILIQUIN 132	153.0	Single Circuit Concrete Pole
99W	WAGGA 132	WAGGA 330	9.8	Double Circuit Steel Tower
99X	WAGGA 132	WAGGA 330	10.3	Double Circuit Steel Tower
99Z	ALBURY	A.N.M.	9.7	Single Circuit Wood Pole
9U2	INVERELL	MOREE	143.0	Single Circuit Concrete Pole
9U3	GUNNEDAH	NARRABRI 132	98.9	Single Circuit Wood Pole
STUB1	ARMIDALE	FIELD TERMINATED	3.7	Single Circuit Wood Pole
STUB2	COFFS HBR.132	FIELD TERMINATED	3.3	Single Circuit Wood Pole

Assets constructed at rated voltage: 66 kV

In Service at 66 kV:				
81Y	MT PIPER	MT PIPER 132	1.06	
875	GUNNEDAH	TAMWORTH 132	64.9	Single Circuit Wood Pole

Appendix C

Project	2001/02 Estimate $000	2002/03 Estimate $000	2003/04 Estimate $000	2004/05 Estimate $000	2005/06 Estimate $000
Capital Expenditure Budget 1998 - 2003					
ANM - Albury 132 kV Transmission Line	750	-	-	-	-
Armidale - Liddell 300 kV Transmission Line	135	2,998	4,343	47,040	93,258
Canberra Substation	5,180	-	-	-	-
Circuit Breakers/Current Transformers	7,738	6,567	4,303	4,855	4,499
Coffs Harbour 330/132 kV Substation	-	-	5,180	15,886	-
Glenn Innes - Inverell 132 kV T/Line	78	782	1,793	6,393	-
Icely Supply Complex	518	9,358	3,769	-	-
Information Systems Equipment	13,544	12,003	9,578	9,528	13,525
Kemps Creek - Sydney South 330 kV T/Line	-	-	1,036	10,429	20,000
Kempsey - Nambucca - Coffs Harbour 132 kV Complex	26,987	9,527	1,227	500	100
Koolkhan 132/66 kV Substation	645	-	-	-	-
Lismore Area 330 kV Reinforcement	83	1,912	17,827	42,764	34,233
Miscellaneous Equipment	1,206	1,032	1,057	918	800
Molong - Manildra 132 kV T/Line	2,599	390	-	-	-
Motor Vehicles	6,928	5,460	5,496	5,186	5,564
Mount Piper - Icely 330 kV T/L	-	2,072	10,498	-	-
Northern Microwave Replacement	7,380	-	-	-	-
Port Macquarie SVC	-	-	1,036	11,465	-
Queanbeyan Substation Augmentation	1,650	-	-	-	-
Queensland Interconnection	2,280	-	-	-	-
SCADA Replacement	2,187	-	518	1,589	-
South Australia Interconnection	9,521	107,676	14,365	-	-
Southern Microwave Replacement	500	-	-	-	-
Substation Projects	7,834	13,043	22,393	12,438	11,494
Sydney City CBD Project	77,143	95,649	37,713	-	-
Sydney City Reinforcement - 3rd Cable	-	-	-	7,251	61,605
Sydney Static Var Compensator	532	9,037	15,049	-	-
Sydney West Substation			1,036	11,465	-
Sydney West/Yass/Marulan 330 kV T/Line	21	260	1,055	20,808	-
System Reactive Plant	4,598	4,848	13,386	1,500	500
Tamworth - Gunnedah 132 kV T/L	62	1,040	3,182	7,590	1,106
Tamworth 330/132 kV Substation	3,990	-	-	-	-
Technical Service Projects	4,197	3,282	1,820	1,820	1,380
Transmission Lines Projects	4,007	6,341	7,346	10,576	9,010
Tuggerah 330/132 kV Substation Augmentation	-	-	-	1,036	69
Tumut Transformer	2,000	-	-	-	-
Wagga 132/66 kV Substation	62	2,283	675	1,031	-
Waratah West 330/132 kV Substation	-	-	11,500	-	-
Yass - Wagga 330 kV Transmission Line	997	5,401	43,688	7,759	5,955
Yass 330/132 kV Substation	584	10,963	12,796	2,753	-
	195,936	311,924	253,665	242,580	263,098
Major Operating Projects Expenditure Budget 2001 - 2006					
PCB Disposal	650	850	500	500	250
Environmental	390	750	750	600	600
Transformer Refurbishments	1,190	840	1,050	1,050	1,200
Cable Investigations and Repairs	60	60	290	50	50
Circuit Breaker Refurbishments	440	400	200	200	200
Instrument Transformer Refurbishments	770	450	300	300	250
Transmission Line Work	650	1,380	1,390	900	900
Relay Replacements/Refurbishments	1,000	1,000	1,000	1,400	1,400
Substations Refurbishments, Security and Building Maintenance	1,600	1,600	1,700	1,700	1,800
Totals	6,750	7,330	7,180	6,700	6,650