APPENDIX 9

Transend Networks Transmission system management plan

Transend Networks Transmission System Management Plan

2007-2012

TRANSEND

About the Transmission System Management Plan

The Transmission System Management Plan (TSMP) provides stakeholders with an overview of the environment in which Transend Networks Pty Ltd (Transend) operates and the systems that Transend uses to effectively and efficiently manage the delivery of electricity transmission services to customers. It is also an integral part of Transend's reporting processes to meet Tasmanian electricity transmission licence obligations.

The TSMP outlines the asset management framework and systems that Transend uses to manage its electricity transmission infrastructure throughout the asset life-cycle. It also provides an overview of the assets that comprise the electricity transmission system and summarises the strategies that must be implemented to address safety and environmental risks and to sustain or improve the performance of the electricity transmission system.

Sustaining a reliable electricity supply is a vitally important function that Transend must undertake to meet stakeholder requirements. The TSMP provides an overview of the transmission system service and performance standards (set internally, by customers and by regulators) that Transend must strive to achieve.

The development of the electricity transmission system to meet prescribed compliance obligations and to cater for load growth and new customer connection requirements is a significant component of Transend's activities. Rigorous planning and investment evaluation processes are critical to ensuring the electricity transmission system is cost-effectively developed in an efficient manner consistent with Transend's long-term vision. The TSMP provides an overview of the planning and investment assessment processes that Transend uses to ensure the efficient development of the electricity transmission system.

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PURPOSE

The TSMP is intended to provide information to stakeholders on the environment in which Transend operates and on the systems and processes it uses to effectively and efficiently manage the delivery of electricity transmission services to its customers. Transend's stakeholders include: shareholders, customers, consumers, regulators, employees, land owners/neighbours and the general public.

Transend's mission and strategic performance objectives acknowledge the need to comply with the National Electricity Market (NEM) objective and are underpinned by the asset management model, systems and processes described in this document. The TSMP assists Transend comply with the following national electricity market objective, incorporated in the National Electricity Law (NEL):

To promote efficient investment in, and efficient use of, electricity services for the long-term interests of consumers of electricity with respect to price, quality, reliability and security of supply of electricity and the reliability, safety and security of the national electricity system.

The TSMP is also an integral part of Transend's reporting processes to meet Tasmanian electricity transmission licence obligations.

SCOPE

This TSMP covers all assets that comprise the authorised transmission system within Tasmania as defined in the licence and includes:

- Transmission lines, transmission cables, and associated easements and access tracks.
- Substations, switching stations and transition stations including associated electrical plant and buildings and civil infrastructure.
- Protection control, metering, Supervisory Control and Data Acquisition (SCADA) and telecommunications equipment.

The TSMP also discusses the policies and systems that support the asset management process.

PLANNING PERIOD AND REVIEWS

The TSMP has a nominal planning period of five years and is reviewed annually. The strategies defined in this planning period have been developed taking into account management over the entire asset life cycle.

The annual review takes place concurrently with annual planning activities required to comply with local jurisdiction and NEM regulations.

The TSMP comprises the following:

Chapter 1:
Provides an overview of Transend, the Tasmanian transmission system and the regulatory environment.

Chapter 2:
Outlines the asset management framework and systems adopted by Transend to ensure appropriate transmission system performance.

Chapter 3:
Discusses the service standards which are key drivers of the asset management processes necessary to ensure required asset and transmission system performance and the performance monitoring framework.

Chapter 4:
Provides information on Transend's approach to transmission network development, key drivers including regulatory planning and reporting requirements.

Chapter 5:
Provides profiles of existing assets including information on some specific asset management issues and strategies.

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Tasmanian Electricity Transmission System Overview

Transend Networks Pty Ltd owns and operates the electricity transmission system in Tasmania. Transend transmits electricity from power stations to its substations around the State. The company owns 3 650 circuit kilometres of transmission lines, 47 substations and nine switching stations.

Transend is registered with NEMMCO as a participant in Australia's National Electricity Market (NEM). The NEM operates on an interconnected power system that extends from Queensland to South Australia. Tasmania is connected to the NEM via Basslink, a direct current link across Bass Strait.

Chapter 1

Tasmanian Electricity Transmission System Overview

1.1 Introduction

1.2 Transend

1.3 Tasmanian Transmission System

1.4 Tasmanian Regulatory Arrangements

1.5 National Regulatory Arrangements

1. TASMANIAN ELECTRICITY TRANSMISSION SYSTEM OVERVIEW

1.1 INTRODUCTION

This section provides an overview of Transend Networks Pty Ltd (Transend) and the Tasmanian electricity transmission system. It also describes the regulatory environment in which Transend operates.

1.2 TRANSEND

Transend owns and operates the electricity transmission system in Tasmania. Transend transmits electricity from power stations to its substations around the State.
The company owns 3 650 circuit kilometres of transmission lines, 47 substations and nine switching stations. Transend is a participant in the NEM operating in accordance with the National Electricity Rules (NER) and the local jurisdictional requirements under the terms of its licence issued by the Tasmanian Energy Regulator under the *Tasmanian Electricity Supply Industry Act 1995* (ESI Act).

Refer to Figure 1.1 (Tasmania's electricity supply industry).

Transend has placed substantial effort into developing the business processes and systems necessary to efficiently and effectively manage the transmission system infrastructure.

In the nine years since inception, Transend has invested more than $500 million in the refurbishment and development of the Tasmanian transmission system. This level of investment has largely been driven by the imperative to ensure a reliable and secure electricity transmission service to customers, the need to provide increased capacity to cater for load growth and the requirement to cater for new connections to the transmission network. Transend's transmission system infrastructure is currently valued at more than $1 billion.

1.3 TASMANIAN TRANSMISSION SYSTEM

The Tasmanian transmission system is characterised by a backbone network predominantly operating at 220 kV that connects main generation locations to major load centres, including major industrial customers. A transmission network predominantly operating at 110 kV provides connections to other generators and regional load centres.

The evolution of Tasmania's transmission system has been heavily influenced by the location of geographically-dispersed power stations and load centres. In particular, a number of generators located at remote sites require extensive transmission infrastructure that traverses inhospitable and environmentally-sensitive terrain.

Unlike the majority of Australian transmission companies, Transend owns the high voltage assets that provide the connection to the customer's distribution feeders. These connection assets comprise a significant proportion of Transend's regulated asset base.

A high-level summary of the composition of Transend's transmission system infrastructure is provided in Table 1.1.

Table 1.1 - Transend's transmission system infrastructure

Number of substations	47
Number of switching stations	9
Number of transition stations	2
Circuit kilometres of transmission lines	3 650
Route kilometres of transmission lines	2 350
Easement area (Ha)	10 500

The Tasmanian transmission system is connected to the mainland Australian transmission system via the privately-owned interconnector, Basslink. Basslink has both supply and demand capability.

In 2006–07, 11 565 GWh of energy was transmitted, which is almost six per cent more than the amount in 2005–06. Maximum demand in Tasmania was 1821 MW and total maximum demand (Tasmania plus export via Basslink) was 2 415 MW, 15 per cent more than 2005–06.

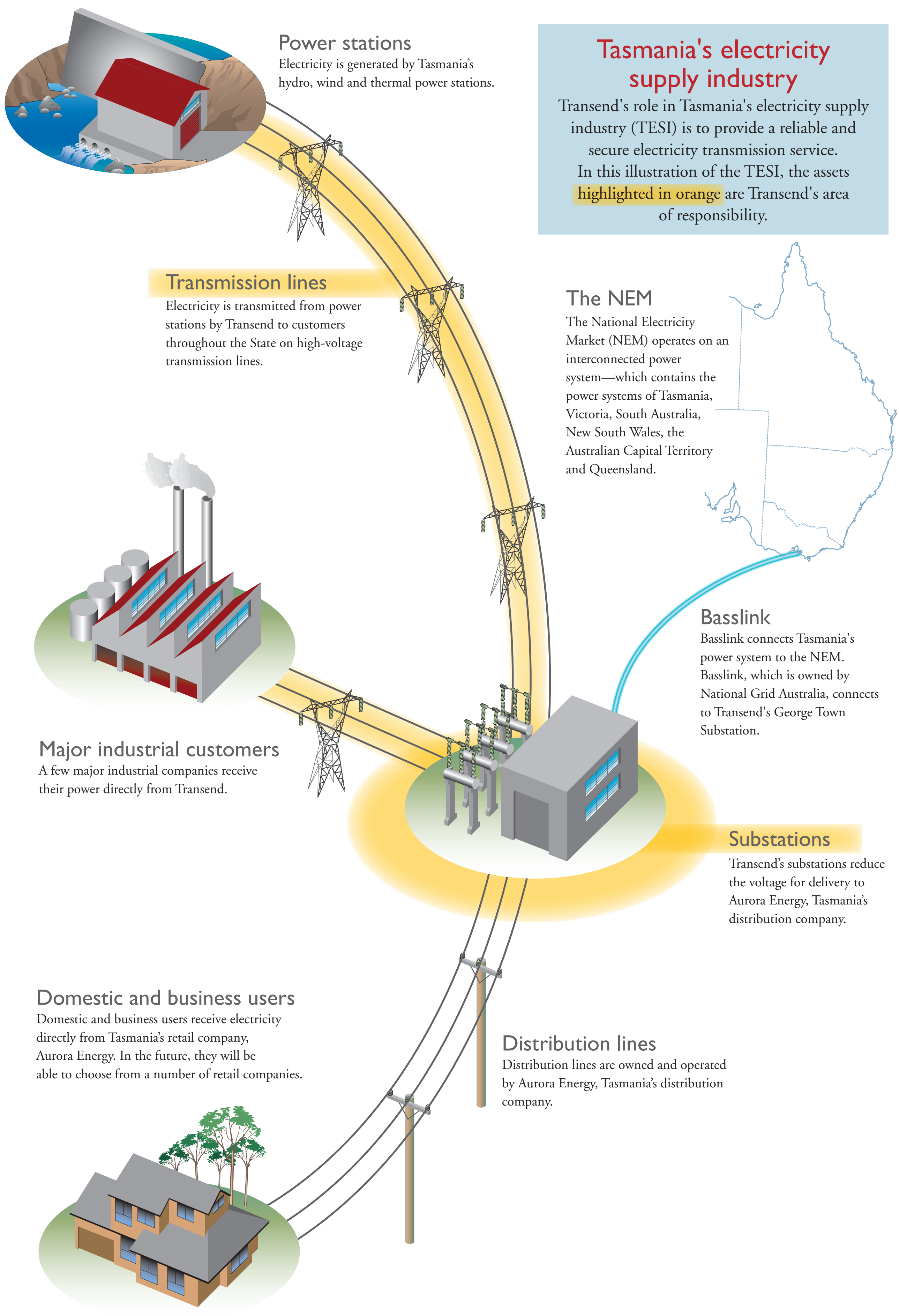
The electricity transmission system is represented in Figure 1.2 (Tasmania's Electricity Transmission System).

1.4 TASMANIAN REGULATORY ARRANGEMENTS

Transend is licensed by the Tasmanian Energy Regulator to operate the electricity transmission system in Tasmania.

Tasmania became a participating jurisdiction in the NEM in May 2005. In the NEM the Tasmanian Energy Regulator remains as licensing regulator with continued responsibilities under the ESI Act.

Figure 1.1 - Tasmania's electricity supply industry



In anticipation of participating in the NEM, arrangements were made at State and Commonwealth Government levels to enable the Australian Competition and Consumer Commission (ACCC) to undertake economic regulation of Transend, as an agent of the Tasmanian Energy Regulator. It was under these powers that the ACCC set Transend's revenue cap for the period 1 January 2004 to 30 June 2009.

Transend remains subject to a number of industry-specific Tasmanian Acts including:

- *Tasmanian Electricity Supply Industry Act 1995.*
- *Electricity Companies Act 1997.*
- *Electricity Wayleaves and Easements Act 2000.*
- *Electricity Ombudsman Act 1998.*

1.5 NATIONAL REGULATORY ARRANGEMENTS

The NEM operates on an interconnected power system that extends from Queensland to South Australia, including Tasmania via Basslink. Refer to Figure 1.2 (Tasmania's Electricity Transmission System). Within the NEM, the National Electricity Market Management Company (NEMMCO) is responsible for managing the security of the national power system and operating the wholesale electricity market. NEMMCO requires Transend to continually monitor power system security in some sections of the Tasmanian transmission system. Transend is also obligated to retain the capability to manage power system security for the entire Tasmanian transmission system in the event that NEMMCO is unable to fulfil its system security obligations in Tasmania.

The Australian Energy Regulator (AER) is responsible for the regulation of electricity transmission services in the NEM. This includes responsibility for determining the maximum allowable revenue for regulated electricity network service providers. Transend's next revenue proposal for the period 1 July 2009 to 30 June 2014 must be submitted to the AER in May 2008. Transend must manage its operating and capital expenditure under the close scrutiny of the AER.

Transend also actively participates and contributes to the development of industry policy, market arrangements and regulatory instruments to maximise the long-term interests of consumers of electricity, the electricity system and Transend's shareholders.

Figure 1.2 - Tasmania's electricity transmission system

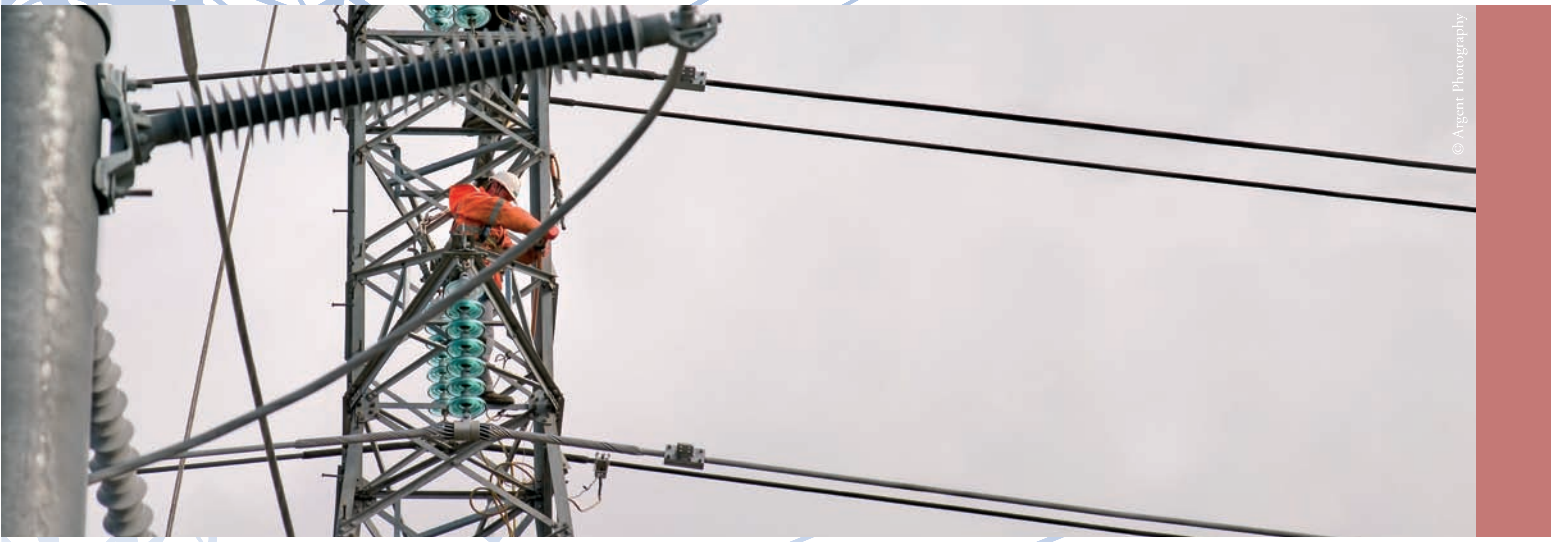
Asset Management Framework and Systems

Transend has developed a comprehensive asset management framework and a series of systems to ensure the most appropriate and effective transmission system performance.

The company recognises that the success of an asset-intensive regulated utility is based on a robust and detailed asset management framework, relying on three critical components: People, Process and Technology.

The goal of infrastructure asset management is to meet a required level of service in the most cost-effective manner, through the prudent and efficient management of assets for present and future customers. Transend continues to improve its asset management capabilities in a manner consistent with industry best practice.

Transend's asset management framework is supported and defined by an extensive suite of documentation.



Chapter 2

Asset Management Framework and Systems

2.1 Introduction

2.2 Asset Management Framework

2.3 Strategic Asset Management

2.4 Asset Management Information System

2.5 Safety Management

2.6 Environment Management

2.7 Quality Management

2.8 Network Training Management

2.9 Risk Management

2.10 Compliance Risk Review

2.11 Business Continuity Management

2.12 Other Support Systems

2. ASSET MANAGEMENT FRAMEWORK AND SYSTEMS

2.1 INTRODUCTION

Transend has developed an asset management framework and a series of systems designed to deliver work programs that consistently achieve Transend's strategic performance objectives.

As part of Transend progressively enhancing its asset management practices, Transend has developed an asset management framework and assessment model consistent with Strategic Asset Management (SAM) principles.

Transend is also continuing to develop its Asset Management Information System (AMIS). AMIS is a system that interlinks asset management processes and information through the entire asset life cycle including asset creation, asset operation and maintenance, asset performance and asset decommissioning.

Key support systems are developed and continually improved for environmental, safety and quality management of Transend's products, services and standards.

Transend's Statements of Corporate Intent clearly articulate the organisation's commitment to safety and environmental management:

- Together we will enjoy a safe, respectful and stimulating work environment that promotes innovation, encourages career development and makes Transend an employer of choice.
- Together we will strive for excellence in environmental management and be a good corporate citizen.

Three key systems and processes support the business operation and these are:

1. Environment Management System (EMS),
2. Safety Management System (SMS), and
3. Risk Management System (RMS).

The EMS is formally certified to the International Management Standard ISO 14001. The system is externally audited by Bureau Veritas International (BVQI).

The SMS is being developed to AS/NZS 4 801, and is being implemented via an annual safety management plan. Key components of the SMS are the Power System Safety Rules, which establish a system of uniform and safe operating practices in accessing the power system.

At a whole-of-business level, the RMS is managed to Australian Risk Management standard, AS/NZS 4360.

Quality management is a key requirement for Transend Networks and is principally managed through the contractor management plan process which requires a quality management plan from all major contract groups.

All of the above systems and processes underpin business operations and are crucial to ensure business risk is effectively managed.

Underpinning any management system are the various tools, processes and support systems that implement the management system and execute normal network management functions within the organisation. Many of Transend's support systems use IT systems which support the following areas:

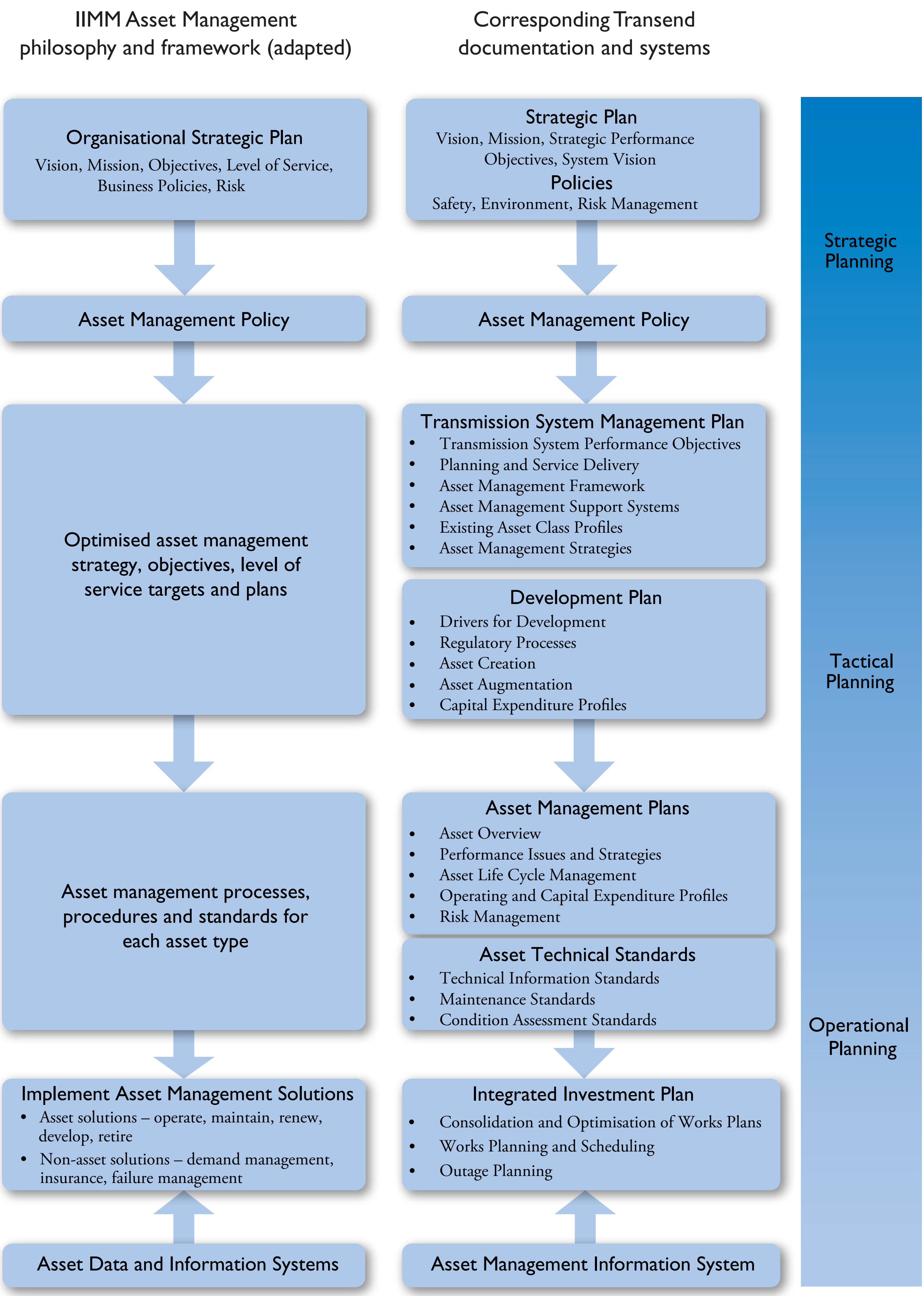
- Asset information management.
- Community relationship management.
- Customer management (including easement inquiries).
- Incident/accident investigations.
- Outage management and coordination.
- Project management.
- Works management.

2.2 ASSET MANAGEMENT FRAMEWORK

Transend has developed an asset management framework that is supported and defined by an extensive suite of documentation. The documentation framework is modelled around the total asset management process as presented in the International Infrastructure Management Manual (IIMM).

Figure 2.1 (Asset management document framework) shows the Transend documents that support the asset management framework, referenced to the corresponding IIMM documentation and/or process, adapted to meet Transend's specific needs. The diagram highlights the existence of, and interdependence between, strategic, tactical and operational planning documentation.

Figure 2.1 - Asset management document framework



2.3 STRATEGIC ASSET MANAGEMENT

The success of an asset-intensive regulated utility is based on a robust asset management framework. An asset management framework relies on three critical components: People, Process and Technology.

The goal of infrastructure asset management is to meet a required level of service in the most cost-effective manner, through the prudent and efficient management of assets for present and future customers. The key elements of infrastructure asset management are:

- adopting a life-cycle approach;
- developing cost-effective management strategies for the long term;
- providing a defined level of service;
- monitoring performance;
- understanding and meeting the impact of growth through demand management and infrastructure investment;
- managing risk associated with asset failures;
- sustainably using physical resources; and
- continually improving asset management practices.

A formal approach to the management of infrastructure assets is essential to providing services in the most cost-effective manner, and in Transend's ability to demonstrate this management approach to customers and other stakeholders (particularly economic regulators).

SAM strives to deliver the following features and benefits:

- Asset management strategy that is consistent with the corporate strategic plan, grid vision and the development plan.
- Long-term, whole-life plans with cost-risk-performance optimisation.
- Aligned and complementary objectives and performance measures.
- Risk-based strategies developed with appropriate use of predictive methods, problem solving and iterative continuous improvement.
- Asset management plans developed from a thorough asset knowledge including condition, performance and strategic factors.
- Asset registers with high data content on a very large proportion of infrastructure assets, where asset information is regularly updated, incorporating condition and asset performance information and histories of work undertaken on assets.

2.3.1 Assessment model

In 2005, Transend elected to incorporate the principles covered by the IIMM for the company's asset management framework. The IIMM is an industry 'best practice' guide to asset management and is a document referenced by many regulators and other industry participants.

The methodology adopted for the assessment of a strategic asset management framework included:

- the development of an end-to-end framework based on IIMM including identification of the major asset management processes;
- an assessment of Transend's present capability for each process;
- the definition of a preferred future position; and
- the definition of the program required to extend asset management processes progressively over three to four years.

2.3.2 Processes summary

SAM comprises eight inter-related processes. An overview of these processes is provided overleaf.

Process area	Main focus
Asset Information	Asset register, asset attributes, the integration of various support tools, the capture of work done on assets, asset condition information and reports to support the management process.
Customer Considerations	The definition of service obligations in connection agreements, the extent to which Transend understands its customer needs, the monitoring of its obligations, management of the relationship and identification of improvement opportunities.
Performance Monitoring	Objective measurement of performance against targets, reporting an analysis of those outcomes, benchmarking and the incorporation of outcomes into plans.
Network Strategy	A forward-looking view of the network (grid vision). Satisfaction of demand and associated network improvement based on technological advancement, and emerging compliance issues are aspects of a defensible long-range capital expenditure plan.
Investment Program	The processes which lead to rational and well-supported investment projects including risk management, ways in which new targets are identified, the evaluation of projects and how programs are monitored.
Capital Works Delivery	The processes that support the prudent and efficient capital expenditure (capex) and include Transend's internal accountabilities as project owner and project manager for the delivery stage.
Sustaining Assets	Deals with maintenance practices to allow assets to achieve their design/economic life and begins with a comprehensive asset management plan detailing work targets. Information on asset performance, condition, risk and work done should also be captured in the database (asset register) and translated into asset strategy in the asset management plans.
Operational Works Delivery	Demonstrates that expenditure is prudent and efficient by examining cost management and contract management processes and the way cost efficiency is evaluated.

2.3.3 Consolidated results summary

Over the period 2005 to 2006, asset management competency in Transend has demonstrated significant improvement.

Transend has established a strong foundation for its asset management applications and is now refining those applications into a more systematic approach.

More sophisticated information exchange will occur as the application of advanced tools through the AMIS program becomes more widespread.

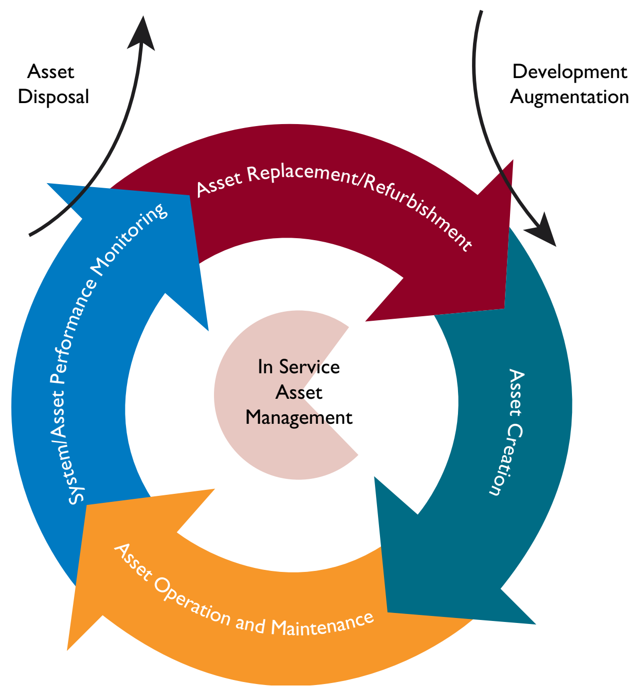
A key challenge is to strengthen the effective use of information to drive strategy development.

2.4 ASSET MANAGEMENT INFORMATION SYSTEM

2.4.1 Introduction to Asset Management Information System

AMIS is a combination of people, processes, and technology applied to provide the essential outputs for effective asset management. These outputs include: reduced risk, enhanced transmission system performance, enhanced compliance, effective knowledge management, effective resource utilisation and optimum infrastructure investment. AMIS is a tool that interlinks asset management processes through the entire asset life cycle including asset creation, asset operation and maintenance, asset performance and asset decommissioning. Refer to Figure 2.2 (asset management cycle). It also provides a robust platform for the extraction of relevant asset information for various purposes.

Figure 2.2 - Asset management cycle



2.4.2 AMIS program

Transend has actively been developing its AMIS for the past several years. The company has a structured program that facilitates the development of an effective AMIS.

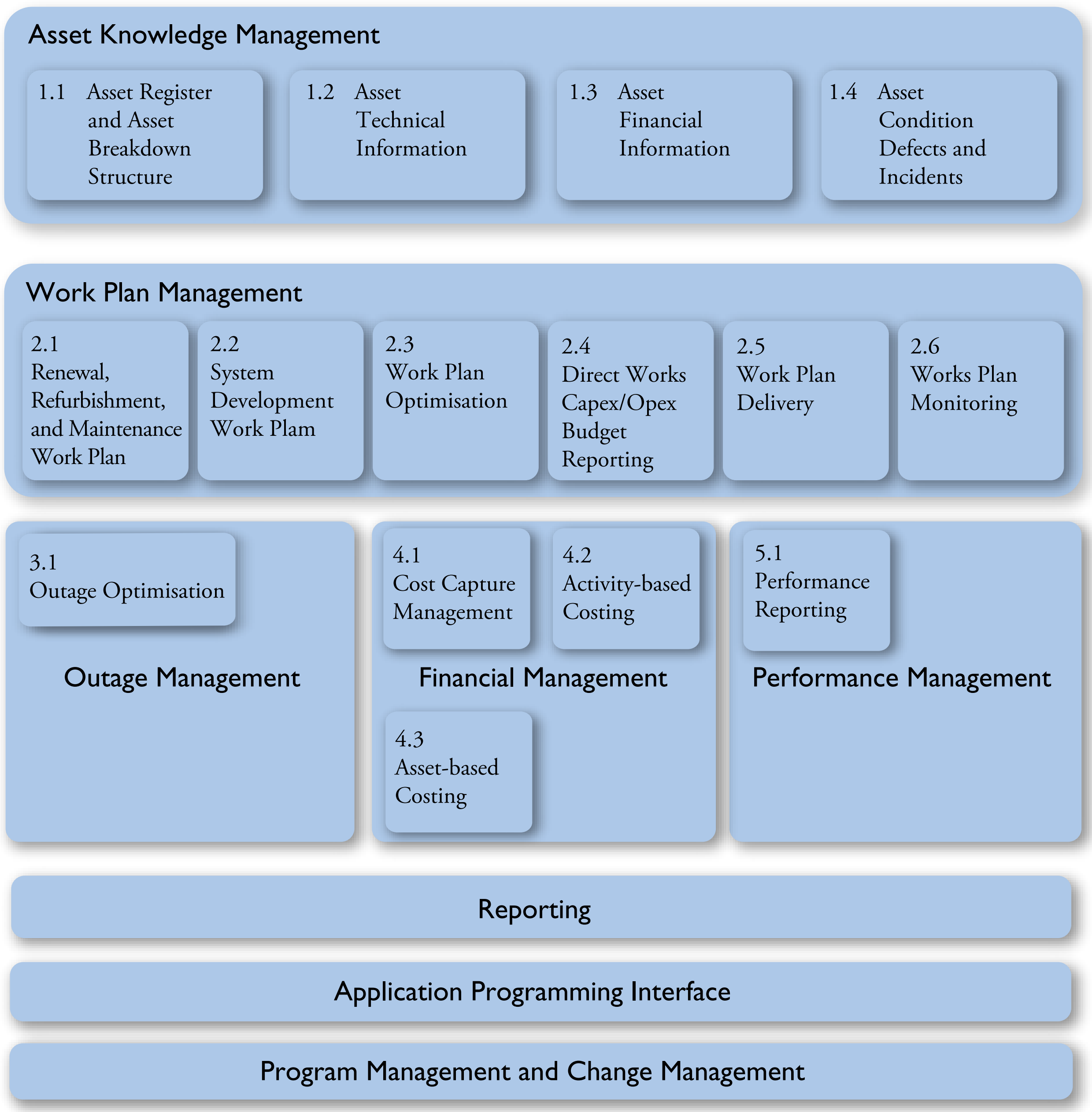
The AMIS program is regularly reviewed and key stakeholders are provided with the opportunity to participate in the development of the detailed scope and priority. The current program scope is expected to be delivered by April 2009. Ongoing system enhancements, developments and some fine-tuning are likely to be required following the completion of the program.

The purpose of the AMIS program is to deliver an integrated business system and suite of business processes for the management of Transend's transmission system assets. The program comprises the following major program elements, each of which comprises one or more specific projects:

- Asset knowledge management.
- Financial management.
- Outage management.
- Performance management.
- Work plan management.

These elements and the identified projects are presented in Figure 2.3 AMIS Program.

Figure 2.3 - AMIS Program



AMIS will enable the seamless integration of the various asset management processes using a suitable combination of manual and automatic tools and systems. This is expected to deliver increased organisational efficiency and effectiveness.

The program seeks to:

- consolidate and integrate transmission system asset management processes and business systems to optimise the cost of undertaking and performing asset management;
- enhance the capability to deliver increased scope and nature of services associated with transmission asset management and assist with the capacity to meet the capital development program;
- ensure that all transmission system technical and financial asset data is collected, managed and maintained in endorsed business systems to ensure the integrity of the data and minimise the cost of data management;
- implement asset-based and activity-based costing processes to support work performance and contractor performance reporting; and
- ensure consistency in processes, nomenclature and identification of assets across all business systems and across all business groups.

AMIS program context, scope, structure and delivery methodologies are defined within a program management plan.

The key achievements of the AMIS program since inception include:

- development of an asset data management policy and associated procedures;
- development of standards and systems relating to:
    - asset identification
    - asset breakdown structures
    - circuit identification and associated relationship between assets to individual circuits
- significant improvements to the asset commissioning and decommissioning process in relation to timing of entry/removal of an asset to/from AMIS;
- development of a works plan management system to register the long-term substation primary, substation secondary and transmission line operational works plans and the capital works plan;
- development of a works prioritisation system to systematically register and assess the relative priority of each project within the capital works plan;
- development of a ratings information system to calculate circuit ratings using the transmission network asset register;
- development of transmission system performance reporting system;
- implementation of a consistent defect management system for substation primary and substation secondary assets;
- implementation of an incident reporting and management system to introduce a single common process to transmission network audit and incident investigation management;
- implementation of a test results module including condition reports for power transformer assets; and
- development of an asset registration sheet system to automate a previously manual process by loading asset data directly into the transmission network asset register.

2.4.3 Planned initiatives/focus

The AMIS program focuses on the following activities during 2007-08:

- Development of system integration between the long-term works planning system and the operational job-packaging and issuing system.
- Development of systems to support pricing categories and customer information.
- Implementation of processes and systems to enhance defect management of transmission lines assets.
- Ongoing enhancement and development of the works planning system.

2.5 SAFETY MANAGEMENT

A key strategic performance objective for Transend is providing a healthy and safe work environment. Transend recognises its duty of care obligations to provide and maintain systems of work, and plant and equipment in a safe condition. Transend acknowledges that this duty of care extends not only to employees, but also to its contractors and members of the public who may be affected by its business activities. Transend aims to conduct its operations in accordance with all health and safety laws, regulations and codes of practice to which it subscribes.

A Safety Management System (SMS) is being developed to AS/NZS 4801, and is being implemented via an annual Safety Management Plan (SMP). The objectives of the SMP are to:

- Achieve the aims of Transend's Health and Safety Policy (refer Appendix A).
- Meet Transend's strategic result area: safety and work environment.
- Identify key safety risks and control measures.
- Prioritise safety performance improvement initiatives according to risk and current business needs.
- Improve safety performance through a structure which is systematic and manageable.
- Enhance Transend's Safety Management System (SMS).

The SMP defines how the specific safety objectives, actions, measures and targets will be achieved.

A key component of the SMS are the Power System Safety Rules that establish a system of uniform and safe operating practices in accessing the power system.

Transend's SMS also includes a contractor management system incorporating planned inspections, audits and on-the-job work site hazard identification and assessment. This assessment uses risk management principles to assess risks and implement appropriate controls. A formal accident or incident investigation and reporting procedure is also part of the system.

Transend evaluates safety risks and the strategies and controls that are in place to address the identified risks.

The asset management-related safety risks are managed through the asset management strategies and technical standards.

Transend actively promotes safety within the company and to the wider community, using a variety of communication techniques including danger signs on electrical installations and public awareness campaigns, for example, 'Don't Die – Look Up – Look Out'.

A regime of internal audits, initiated by Transend, assesses the level of compliance with prescribed standards and procedures.

2.5.1 Contractor safety management

All field maintenance and construction projects are undertaken for Transend by external contractors. Therefore as the principal, Transend acknowledges it has an obligation to ensure that a contractor engaged to perform work on the company's behalf is safe from injury and risk to health. This obligation also applies to the health and safety of the general public.

To achieve this, Transend has established a rigorous Contractor Management Plan standard. Through its application, safety, quality and environmental issues are managed during three important stages of the contracting process.

1. Contract specification: Transend ensures that appropriate safety, quality and environment requirements are incorporated within specification documents.
2. Tender evaluation: Transend establishes a systematic approach to evaluate the contractor's capabilities and resources with respect to safety, quality and environmental management.
3. Contract management: Transend ensures that contractor safety and environment performance are adequately monitored and supervised for the duration of the contract.

Transend requires tenderers to submit plans for quality, safety, risk and environmental management prior to the award of any contract. Submitted plans are evaluated internally by Transend against the following objectives:

- Ensure personnel and public safety.
- Ensure protection of the environment.
- Address legal requirements.
- Identify, evaluate and control project specific risk.
- Meet customers' requirements.

2.5.2 Power system safety

The Power System Safety Rules establish a system of uniform and safe operating practices in accessing the power system.

Transend, together with Hydro Tasmania, Aurora Energy and Alinta Power Services, is represented on the Tasmanian Power System Safety Committee, which is responsible for maintaining Tasmania's Power System Safety Rules and Electricity Supply Industry (ESI) Passport. These rules and passports apply to employees and contractors who work on or in the vicinity of the power system.

2.5.3 National Electricity Network safety

Transend contributes to various national committees and relevant working groups including active participation on the Energy Network Association (ENA) sponsored National Electricity Network Safety (NENS) project.

Given the growing trend in the electricity industry for employees and contractors to move between organisations and states, consistent safety rules and procedures across jurisdictions will aid in the reduction of the potential for misunderstanding and incorrect interpretation of safety procedures. Another advantage of the national approach is to avoid the duplication of effort required to set and maintain standards.

2.5.4 Safety performance

Transend's safety performance for 2006/07 is shown in Table 2.1.

While the majority of incidents were of unrelated causes, 19 per cent of incidents reported in 2006–07 involved rigging equipment and activities. Three of those incidents also involved helicopters undertaking conductor stringing activities.

Twenty four contractor safety audits were conducted during the year. This represented three times the number of audits conducted compared to the previous year (2005–06). The audit increase was aimed at improving safety performance among contractors and promoting safety.

A total of 14 non-conformances and six opportunities for improvement were identified. All non-conformances have been actioned and closed as at 30 June 2007.

Particular attention will be given to ensuring that the satisfactory condition of rigging equipment, that the correct rigging equipment is being used, and that contractors are competent to carry out rigging activities during audits in 2007–08.

Table 2.1 - Strategic performance measures: safety and work environment

Measure	Target	2006–07
Statutory reportable incidents	0	0
Injury - lost time	0	0
Injury - no lost time	≤ 5	11*

* (2 Employee, 9 Contractor)

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2.6 ENVIRONMENT MANAGEMENT

Achieving environmental excellence is a key strategic performance objective for Transend. Transend recognises its responsibility to give appropriate consideration to, and minimise its impact on the environment and to improve environmental outcomes where possible while managing its business risks. Transend aims to conduct its operations in accordance with all environmental laws, regulations and codes of practice to which it subscribes.

The EMS is formally certified to the International Management Standard ISO 14001 (Environmental management systems – Requirements with guidance for use) and the system is externally audited by BVQI.

Transend is committed to excellence in environment management and has undertaken to ensure continual improvement in its environmental performance. Transend's commitment to environment management is documented in its Environment Policy (refer Appendix B).

This commitment is underpinned by Transend's EMS. The EMS ensures that Transend has appropriate systems in place to meet its legislative obligations and to meet community expectations. It also sets targets to manage risk and to continually improve performance. Monitoring is undertaken to ensure environmental targets are achieved.

Transend recently received renewal of its EMS certification. The audit report issued by BVQI stated: "Transend's EMS is a mature suite of strategies, methodologies, and process control documentation developed on a continual basis over several years. The environmental risks encountered at the various substations and facilities of Transend are considered generally low and quite well understood." The report also stated that "While some power and utilities' companies on a global basis may have more extensive systems, none are documented as well, none are as intuitive to follow as those of Transend, making them more likely to be used properly as intended. The EMS system is well written and well managed and continues to support professionally the day to day operations of Transend."

Certification to ISO 14001 is reassessed every three years and audits are conducted twice a year to ensure conformance to the standard.

The transmission circuits throughout Tasmania are retained on approximately 10 500 hectares of land on transmission line easements across public and private land. Where necessary, Transend cares for the land and vegetation in these easements. Easement management activities include protecting threatened plants and animal habitats, eradicating weeds and protecting Aboriginal and European cultural heritage.

At substation sites, environment management includes the containment of insulating oil and Sulphur Hexafluoride (SF_6) gas, and managing noise and electromagnetic fields.

Transend's EMS embodies risk management principles in the assessment of environmental impacts. Transend evaluates environmental risks and the strategies and controls that are in place to address the identified risks.

2.6.1 Environment Management Plan

A key component of Transend's EMS is the annual Environment Management Plan (EMP).

The objective of the EMP is to:

- achieve the aims of Transend's Environment Policy;
- meet Transend's strategic result area: environmental excellence;
- identify key environment risks and control measures;
- ensure continual improvement in Transend's environment performance;
- ensure compliance with environmental legislative requirements; and
- ensure Transend's environmental risk is managed and minimised.

The EMP comprises objectives and targets developed consistent with the Environmental Policy, and that aims to drive continuous improvement in environmental performance.

Performance against measures are regularly reported to the executive and the board as part of the EMS management review.

2.6.2 Environmental impact assessment

Over the past five years, Transend Networks has maintained an intensive capital works program. Typically, for many infrastructure upgrades and development projects, the planning approval process requires detailed investigation of environmental and cultural heritage values.

For all significant development projects, an environmental impact assessment is undertaken to identify potential environmental risks and appropriate mitigation measures.

A project justification procedure is currently being prepared to outline the minimum requirements for the environmental impact assessment.

The environmental impact assessment identifies areas of concern associated with development projects. The environmental impact assessment typically includes the following areas:

- Geotechnical issues.
- Construction impact (noise, vibration, airborne disturbance).
- Aquatic and terrestrial flora and fauna.
- Water quality.
- Cultural heritage (Aboriginal and European).
- Social impact.

When protected species of flora and fauna are identified in the course of environmental investigations, this information is communicated to Transend employees, contract personnel and work crews. Geographic information systems are utilised to identify where special management practices may be required to protect threatened species.

2.7 QUALITY MANAGEMENT

Transend's focus on quality is demonstrated in its approach to all aspects of asset management. The company continues to enhance its processes, technical and procedural standards as well as associated procedures for all critical aspects of asset management.

Transend reviews the quality management systems of its contractors and ensures through progressive reviews at each stage of works that work done by contractors for Transend is of the appropriate quality.

Transend is developing and implementing systems consistent with the requirements of ISO 9000 with the goal of receiving external certification for its quality systems at the appropriate time.

2.8 NETWORK TRAINING MANAGEMENT

Transend employs a Training Management System that facilitates:

- Development and maintenance of power system safety (PSS) training for employees and contractors to ensure the safe access to Transend's assets.
- A competency-based field operator training system, incorporating Training Record Books (TRB) for all of Transend's operational assets.
- Auditing the training system to verify the level of compliance with policies, procedures and documentation as a measure of the training outcomes.
- Design, implementation and maintenance of network training programs for internal and external service providers.
- Delivery of training for all levels of PSS authorisation, auditing, and the maintenance of the centralised data base of all PSS personnel.
- Management of the Tasmanian Electricity Supply Industry (TESI) Passport and supporting procedures.

Transend maintains and develops training standards that are critical to sustaining personnel safety and system security. Based on national units of competence, the training standards support the national training agenda to achieve consistent skills competencies across the ESI.

In 2007-08, Transend will continue to improve its approach to training coordination of its internal staff and contractors on required in-house standards and processes.

2.9 RISK MANAGEMENT

Transend is committed to maintaining a sound risk management system and processes aimed at maximising shareholder value and preventing breaches of statutory and regulatory obligations. It is recognised that there are risks inherent to the activities undertaken by Transend so it is critical that risk management is an integral part of the day-to-day activities of the business.

Responsibility for risk management is recognised in Transend's *Corporate Governance Charter* which outlines the responsibilities of the board, management, and staff. These responsibilities include the establishment and implementation of sound risk management policies, systems and processes.

The Audit and Risk Committee is charged with the responsibility of assisting the board to ensure that its corporate governance responsibilities are fulfilled in relation to risk management. The *Corporate Governance Charter* outlines the Audit and Risk Committee's role that includes the overseeing of:

- Transend's risk management system.
- The preparation of the business risk review and its continuous monitoring.

Transend's Audit and Risk Committee guidelines provide more detailed guidance on the role that the Audit and Risk Committee performs in relation to risk management.

Transend's Internal Auditor provides assurance to the Audit and Risk Committee and to the board regarding the effectiveness of the company's risk management systems, processes and management controls. This assists Transend to discharge its corporate governance responsibilities in relation to risk management.

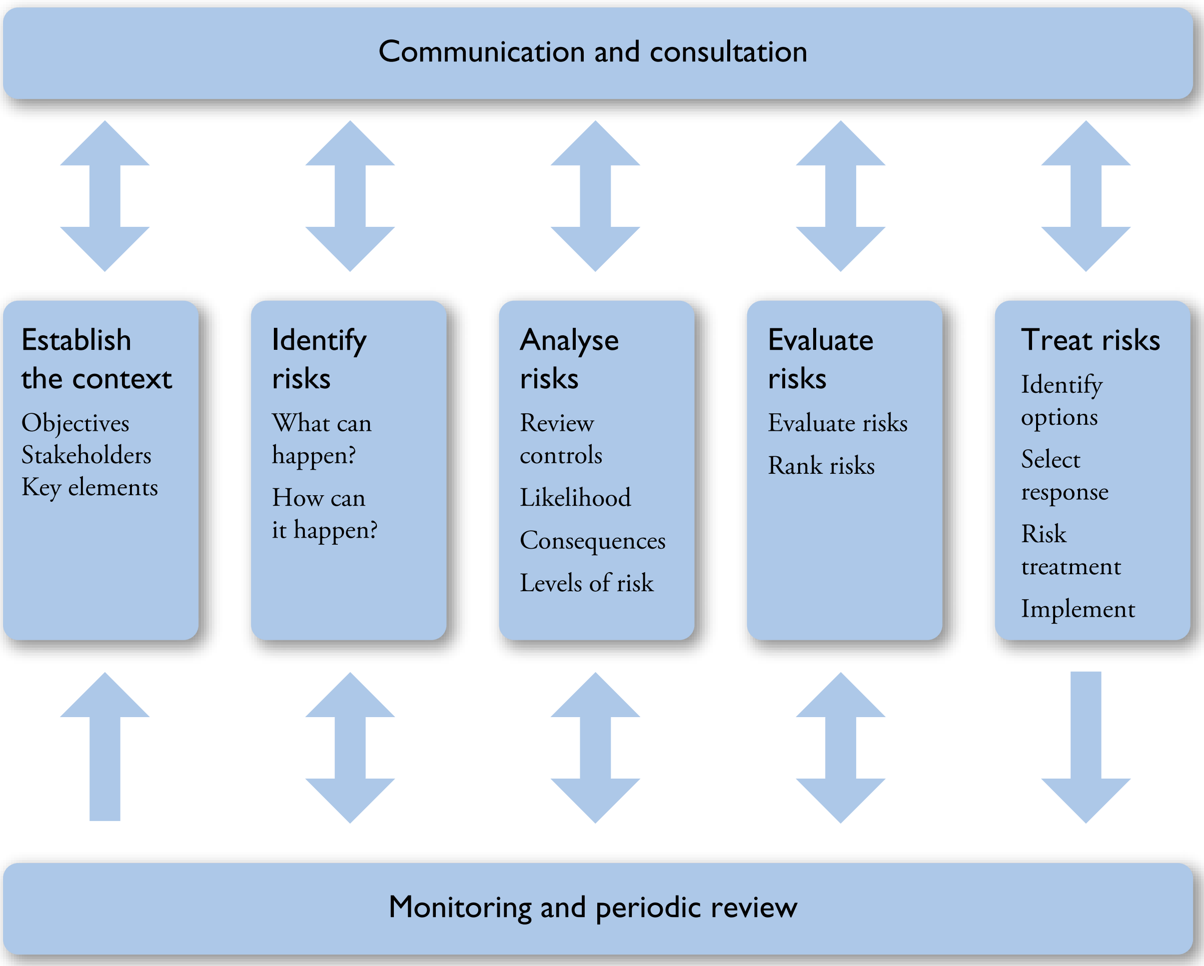
Transend's Risk Management Policy is the overarching document that provides guidance on risk management practices within the company. It is a high-level document that clearly establishes expectations in relation to risk management.

The responsibilities, structures and processes established to ensure Transend achieves its risk management objectives are detailed within the Risk Management Framework.

In accordance with AS/NZS 4360 Risk Management, Figure 2.4 shows the generic approach undertaken by Transend when managing all types of risk.

In 2007-08 Transend will continue to develop and refine its processes for assessing and managing asset-related risks.

Figure 2.4 - Risk management



2.10 COMPLIANCE RISK REVIEW

Transend's Electricity Supply Industry (ESI) Compliance Plan calls for the risk assessment of the obligations imposed on it by various electricity industry-specific regulatory instruments, including the National Electricity Rules (NER), Tasmanian Electricity Code (TEC), ESI Act and licence. Under its licence, Transend is specifically obliged to comply with the NER, as well as the Tasmanian regulatory instruments. This gives the Tasmanian jurisdictional regulator an interest in NER compliance that otherwise would be exclusively the province of the AER.

Transend uses a software tool to assist in managing ESI compliance. This tool provides a central repository for ESI compliance obligations, allows for the automated generation of reminder emails and supports the identification and assessment of risks and control measures. The system compels the assignment of at least one remedial action to any control measure assessed as ineffective.

In this context, the risk which is assessed is that of non-compliance with the obligation. This assessment allows the prioritisation of:

- Compliance effort - so that those obligations where the likelihood and consequences of non-compliance are greatest, can be targeted for immediate action to reduce the risk
- Audit effort - which allows anyone examining Transend's compliance performance to focus on areas where the likelihood and consequences of failure are greatest.

The compliance risk assessment methodology utilised is consistent with Transend's general approach.

2.11 BUSINESS CONTINUITY MANAGEMENT

Transend's assets are classified as part of national critical infrastructure in accordance with Commonwealth Attorney-General's Department guidelines.

Transend has responsibilities for managing emergency events which may relate to the electrical system or to other critical business functions.

Business Continuity Management (BCM) is defined as providing the availability of process and resources to ensure the continual achievement of critical objectives. The scope of BCM is broad and includes:

- preparation and planning for emergency events; and
- responding to emergency events and managing the consequences and recovery from that emergency.

Transend has a system for managing business continuity. The essence of this system is defined within Transend's

Business Continuity Management Framework document.

This document establishes the framework for management of business continuity planning for Transend. The framework encompasses the following areas:

- Structure and responsibilities.
- Training, awareness and communication.
- Change management and document control.
- Audit and review.
- Testing and exercising.

The following documents support the framework by defining structures, responsibilities and procedures:

- Corporate Emergency Management Plan (CEMP) - Provides the over-arching structure, and defines key roles and responsibilities for the coordination of emergency management within Transend. The CEMP addresses preparedness for emergencies, ie events, which impact severely upon the reliability of supply, the safety of staff, contractors and the public and the environment. The CEMP may be enacted as a result of emergency events related to natural causes, acts of sabotage or terrorism, or major system failures.
- Emergency Response Plans - Provides guidance to staff regarding immediate responses to an emergency and actions to be taken until the Crisis Management Team (CMT) is informed, and where applicable, the CMT assumes responsibility for management of the crisis.
- Business Continuity Plans - Provides guidance to the CMT and staff on the management of the consequences of a crisis event, and for the continuity of critical business functions.

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Critical infrastructure protection brings together existing strategies, plans and procedures that deal with the prevention, preparedness, response and recovery arrangements for disasters and emergencies.

Transend is adopting an 'all hazards' approach, which recognises that damage, destruction or disruption to business operations may emanate not only from terrorist threat, but also from natural disasters, negligence, malicious damage or similar.

Transend is an active member of the Critical Infrastructure Trusted Information Sharing Network and participates in a number of critical infrastructure protection committees and working groups that produce various guidelines and strategies.

2.12 OTHER SUPPORT SYSTEMS

In addition to systems mentioned previously, Transend has also implemented several information and asset operation support systems. A number of those key support systems are detailed below.

2.12.1 Plant Restriction, Outage Management System

Plant Restriction, Outage Management System (PROMS) is an application designed and implemented to provide a system for managing outages to Transend's electrical network and to facilitate entry into the NEM.

PROMS ensures that an auditable trail of planned outages is maintained to implement the maintenance and capital upgrade program of Transend's network assets. The system is used:

- as an input for Projected Assessment of System Adequacy (PASA);
- to identify and coordinate outage requirements on network equipment for Transend and other parties;
- to provide outage information to NEMMCO and other code participants; and
- to provide an outage management capability.

With a growing complexity in the outage management process, Transend has recognised a need to enhance its outage management systems and processes, to further integrate these with its own works management systems.

PROMS will be enhanced to make the application available to authorised external project managers who will be able to use it to request network outages. The standardised data entry point will ensure that all required information is provided in a consistent manner before Transend staff receive and review the requests. This will save valuable time while requests for further information are sent back and forth.

2.12.2 Operational information system

Transend is required to maintain operational information for its operators, customers, generators, code participants and NEMMCO. High quality information in this regard is critical to ensure:

- safety of personnel;
- safety of assets;
- reliable and secure operation of the power system.

Transend's operational information system maintains a diverse suite of information including:

- Power circuit one line diagrams.
- Metering and protection one line diagrams.
- Operational one line diagrams.
- Major equipment schedules with rating information.
- Transmission system diagrams.
- Transmission line wire position diagrams.
- Circuit ratings derived from equipment ratings.

The operational information system aims to reduce Transend's risk exposure to incorrect electricity system operations and provides useful information for personnel associated with day-to-day operation of the electricity system.

2.12.3 Document and standards management system

Transend maintains an extensive library of transmission system standards, policies, procedures and processes. A document and standards management system has been developed to facilitate the management of these documents.

A number of significant system enhancements are planned. New system tools are planned for implementation in order to rationalise and improve the efficiency of document creation, review and approval processes. Additionally, as a result of the rapid increase in number of standards maintained by Transend, all published standards will undergo reclassification in order to enhance accessibility to the material.

2.12.4 Landowner and geographical information systems

Continued improvements to the landowner database will be implemented to assist in easement management. Effective easement information management is essential to:

- Achieve timely response to incidents.
- Enhance understanding of the likelihood of interaction between transmission lines and vegetation–and the associated risk of fire and threat to the continuity of supply.
- Sustain a good relationship with landowners, who are key stakeholders in our business.

Transend is implementing a Geographical Information System (GIS) that links network asset information to the data from Land Information System Tasmania (LIST). This will assist in title identification and landowner communications relating to Transend transmission line assets.

Service Standards and Performance

Transend is committed to providing levels of transmission system service that enable it to meet all of its agreed legal, regulatory and customer obligations.

Transend is obligated to undertake performance monitoring and reporting to the Australian Energy Regulator (AER), Office of the Tasmanian Energy Regulator (OTTER) and to customers through connection agreements.

Transend actively undertakes performance monitoring and reporting, performance benchmarking, audits, incident investigations and incident reporting.

Transend uses performance information, asset condition monitoring, system simulation studies and benchmarking activities as a vital input to the asset management process. Transend monitors transmission system performance against the four inter-related elements of supply availability; plant availability, supply security and supply quality.

Chapter 3
Service Standards and Performance

3.1 Introduction

3.2 Measuring Service Performance

3.3 Supply Availability

3.4 Plant Availability

3.5 Supply Security

3.6 Supply Quality

3.7 Transmission Losses

3.8 Performance Monitoring and Reporting

3.9 Australian Energy Regulator Performance Incentive Scheme

3.10 Performance Reporting to Office of the Tasmanian Electricity Regulator

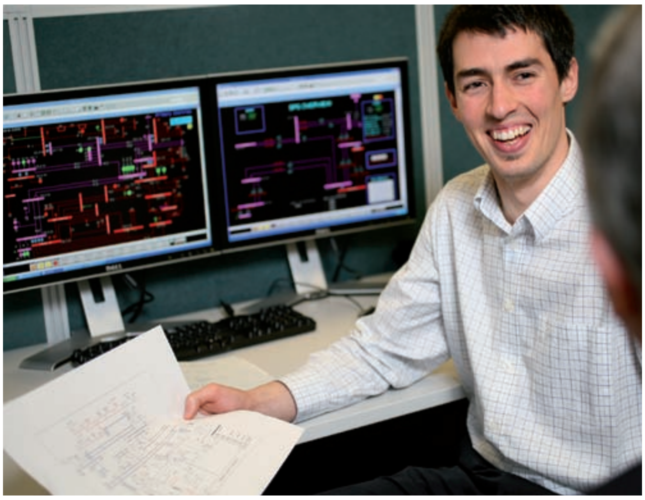
3.11 Customer Service Objectives

3.12 Asset Performance

3.13 Business Process Measures

3.14 Performance Benchmarking

3. SERVICE STANDARDS AND PERFORMANCE



3.1 INTRODUCTION

Transend is committed to providing levels of transmission system service that enable it to meet all of its agreed legal, regulatory and customer obligations. This commitment is reinforced in Transend's mission statement, statements of corporate intent and in the strategic performance objectives.

Transend has obligations for performance reporting to the Australian Energy Regulator (AER), Office of the Tasmanian Energy Regulator (OTTER) and to customers through connection agreements. In meeting the requirements for both regulatory bodies and customers, Transend actively undertakes:

- Performance monitoring and reporting.
- Performance benchmarking.
- Performance improvement activities.
- Audits.
- Incident investigations and reporting.

Together with other business objectives, Transend's performance against prescribed service standards is a key driver in the asset management process.

3.2 MEASURING SERVICE PERFORMANCE

The principal objective of measuring service performance is to assess the underlying 'health' of the transmission system to ensure an ongoing reliable supply of electricity. Transend uses performance information, asset condition monitoring, system simulation studies and benchmarking activities as a vital input to the asset management process.

Transend monitors transmission system performance against four inter-related elements:

- Supply availability;
- Plant availability;
- Supply security; and
- Supply quality.

Measures associated with each of these elements are reported in the following sections.

3.3 SUPPLY AVAILABILITY

Supply availability measures the impact on Transend's customers of supply interruptions. Supply interruptions are either planned or unplanned. Planned interruptions (defined as interruptions where there is more than 24 hours notice) are not included in this measure.

Transend monitors supply availability using the Number of Loss-of-Supply (LOS) events measure. Transend monitors the number of LOS events in the following categories:

- events greater than 0.1 system minutes, and
- events greater than 2.0 system minutes.

This is outlined in Table 3.1.

Detailed investigations are undertaken for all LOS events. The root cause of the LOS events is established, with action plans developed to reduce the likelihood of a reoccurrence.

Table 3.1 - Transmission system Loss of Supply performance

Performance Measure	Target	2006-07	2005-06	2004-05	2003-04	2002-03
Number of LOS events > 0.1 system minutes	≤ 16	13	19	16	16	13
Number of LOS events > 2.0 system minutes	≤ 3	0	1	0	0	1

3.4 PLANT AVAILABILITY

Plant availability is a measure of the time that plant is in service or ready for service, and fit for purpose. It also provides a measure of the amount of time that plant is not in service as a result of planned, forced and fault outages.

Transend monitors the availability of its transmission system assets in the following circuit categories:

- transmission line circuits;
- transformer circuits; and
- capacitor bank circuits.

The availability of transmission line circuits and transformer circuits (Table 3.2) form part of Transend's performance incentive scheme established by the AER. Transend also monitors the availability of supply and demand connection sites as part of its reporting requirements to customers and regulators.

Table 3.2 - Transmission system availability performance

Performance Measure	Target	2006-07	2005-06	2004-05	2003-04	2002-03
Transmission Line Circuit Availability %	≥ 99.10	99.42	98.68	99.29	99.22	98.86
Transformer Circuit Availability %	≥ 99.00	98.88	99.00	99.60	99.22	99.52
Capacitor Bank Circuit Availability %	≥ 99.00	99.71	99.77	99.77	96.17	98.76

3.5 SUPPLY SECURITY

Supply security is a measure of how much redundancy is included in the design of the network.

Both supply and demand connection sites are categorised as firm or non-firm. A firm connection site is one that has sufficient plant diversity and capacity to enable continuity of supply following the loss of one or more network elements. Conversely, a non-firm connection site will lose supply following the loss of a network element.

Customers value firm connection sites because they provide greater certainty that supply will be maintained when a transmission outage occurs. However the provision of this higher level of security comes at a higher cost to the customer. From the perspective of network design, it is important to balance the benefits of a secure supply against the additional costs associated with the provision of plant diversity.

Transend monitors supply security using the following measures:

- Performance against contracted agreements with customers.
- Performance against security and planning criteria.

3.5.1 Performance against contracted agreements with customer

Transend determines the level of security of a firm connection site by monitoring plant outages. As part of its customer and regulatory requirements, Transend reports the instances where a firm connection site becomes non-firm due to plant outages.

The performance of connection site supply security is measured in terms of the frequency and duration of instances when a firm connection site becomes non-firm.

3.5.2 Security and planning criteria

Security and planning criteria determine how the transmission system should be designed and developed. As discussed earlier, there are links with service performance because a network with more 'redundancy' or spare capacity is capable of providing a higher level of service to its customers. Security and planning criteria is a key driver for network development.

Transend reports its compliance with security and planning criteria in its Annual Planning Report. Analysis of where the company is not meeting the criteria provides valuable information to support development plans.

3.6 SUPPLY QUALITY

Transend's customers require a high quality of electricity supply to ensure that their electrical equipment and appliances:

- operate as designed and can be used to full capability;
- operate continuously when required, with minimal risk of interruption; and
- are at minimal risk of damage when connected to the transmission system.

To meet these requirements it is necessary to maintain the following electricity supply parameters within specified limits:

- Frequency.
- Power frequency voltage magnitude.
- Voltage fluctuations.
- Harmonic or notching distortion of voltage.
- Voltage balance.

The operating limits for these parameters are taken into account when planning the development of the transmission system.

Transend recently installed power quality meters at key supply points in the network to allow measurements that assist in reporting power quality, aid investigation into customer service issues and assess compliance to standards. This has been undertaken to identify power quality issues before they manifest in asset failure or customer complaints, and to establish Transend's conformity with agreed power supply quality. Transend measures and reports its supply quality performance on the number of times that quality standards are not met (Tale 3.3 number of validated complaints).

Table 3.3 - Transmission system supply quality performance

Performance Measure	Target	2006-07	2005-06
Number of substantiated complaints	≤ 1	1	0

3.7 TRANSMISSION LOSSES

Apart from the technical performance measures discussed earlier, Transend plans to more accurately monitor transmission energy losses to identify opportunities to improve the transmission system design where appropriate. The level of transmission losses are impacted by network design and mode of operation (eg diversion of power through a less efficient asset for power system security purposes could lead to higher transmission losses). Transend's selection of new assets is influenced in part by:

- properties of existing assets and technical coexistence of new assets with them (eg power transformers need to be purchased based on the impedances of the existing transformers that have to run in parallel to avoid circulating currents and other operational limitations);
- customer requirements (eg certain customers demand high impedance transformers due to the design of their existing system, plant and equipment); and
- other factors specific to an installation.

While Transend does not have full control over the technical parameters of all assets within the transmission system, where

practical, Transend reduces the transmission losses by using higher-efficiency assets.

Transmission losses cannot be accurately determined unless a robust metering infrastructure exists. Transend, Aurora Energy and Hydro Tasmania have recently completed a program to install NEM-compliant metering throughout the transmission network and Transend will now be able to accurately monitor power transmission losses.

3.8 PERFORMANCE MONITORING AND REPORTING

Transend's performance monitoring is driven by:

- regulatory obligations, including:
  - requirements of AER.
  - requirements of its transmission licence.
- obligations to customers (in accordance with Connection and Network Services agreements).
- Transend's own requirements.

The AER requires Transend to report on performance on a calendar year basis in line with other TNSPs. The AER's Service Standard Guideline requires reporting by March each year.

The Tasmanian Electricity Code (TEC) requires Transend to report on performance to OTTER on a financial year basis by September each year. Transend's reports are in line with OTTER's performance measure recommendations.

3.9 AER PERFORMANCE INCENTIVE SCHEME

As a part of Transend's revenue determination, the AER established a Performance Incentive (PI) scheme for the company, based on a number of service standard measures. The intent of the scheme is to reward Transend for improvements in performance, and penalise the company where performance is degraded. There is a 'deadband' where actual performance has seen no impact on revenue.

Transend's present PI scheme is derived from the AER's Service Standards Guideline, Transend's Revenue Cap Application and stakeholder input. The PI scheme is based on the following measures of plant and supply availability.

- Plant Availability:
  - Transmission line circuit availability.
  - Transformer circuit availability.
- Loss-of-Supply Event Frequency Index:
  - Number of events in which loss of supply exceeds 0.1 system minutes.
  - Number of events in which loss of supply exceeds 2.0 system minutes.
- Under Transend's PI scheme:
  - 0.4 per cent of Transend's allowable revenue is at risk against plant availability performance.
  - 0.6 per cent of Transend's allowable revenue is at risk against the loss of supply event frequency index.

The PI scheme is based on performance in a calendar year to align with the schemes of other TNSPs and allow incentive payments or penalties to be reflected in prices in a timely manner.

The AER has established a Service Standards Working Group to look at expanding the scope of future TNSP performance incentive schemes. The present focus is on implementing a transparent regime that analyses transmission constraints and market impacts. The regime is likely to result in performance incentive schemes to reduce the market impact of TNSP actions. The AER is presently drafting its proposed Market Incentive Transmission Congestion scheme and Transend continues to work with the AER in the development of this new scheme.

3.10 PERFORMANCE REPORTING TO OTTER

In February 2007 OTTER released its Electricity Supply Industry Performance and Information Reporting Guideline. Transend reports against the requirements of the guideline as part of its annual performance report to OTTER as required by its transmission licence.

3.11 CUSTOMER SERVICE OBJECTIVES

Under the NER, Transend has connection agreements with its generation, demand and market network service provider customers.

Under these connection agreements, Transend is required to report on the performance of its customers' connection sites. Transend continues to work with its customers to define their requirements for performance monitoring and reporting.

3.12 ASSET PERFORMANCE

Transend is currently undertaking a project to automate the generation of asset performance data through the AMIS. Asset performance will be measured for different asset classes and will consist of a suite of performance measures and key performance indicators for:

- Transmission Line Assets.
- Substation Primary Assets.
- Substation Secondary Assets (Protection).
- Substation Secondary Assets (Control – RTU and SCADA).

Key Performance Indicators (KPIs) for these asset categories are being progressively incorporated in to asset management plans and used to improve performance where appropriate.

3.13 BUSINESS PROCESSES

Business processes are associated with the following key business activities.

Incident Investigation Process: each incident is thoroughly investigated through a formal investigation process based on cause-effect analysis. Investigations normally generate remedial actions used for correction or improvement. Measures are used to track remedial actions.

Outage Planning Process: each planned outage is subject to a formal planning process. Measures are currently being developed and will be finalised in 2008.

Audit Process: as a result of internal and external audits (planned and ad hoc), non-conformances and opportunities for improvement are generated. These non-conformances and opportunities for improvement are tracked from initiation to completion and can be reported as per incident actions.

3.14 PERFORMANCE BENCHMARKING

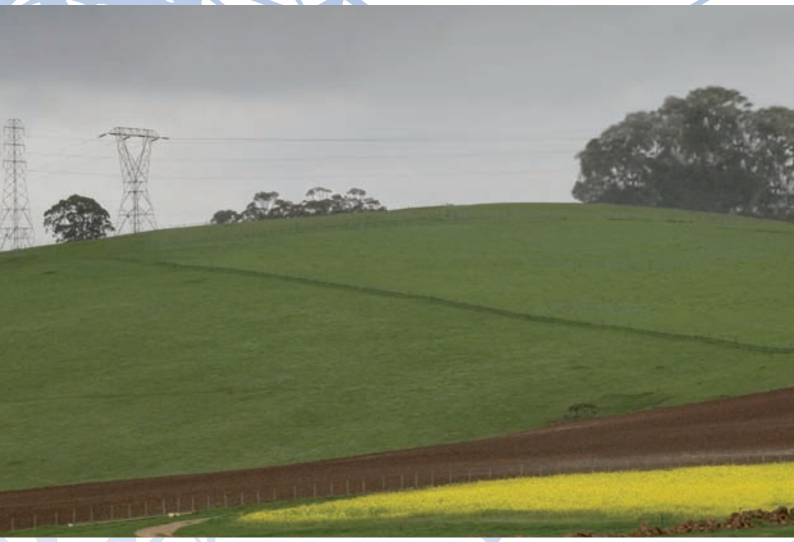
In addition to internal asset performance reporting, Transend participates in the biennial International Transmission Operations and Maintenance Study (ITOMS) benchmarking exercise. The ITOMS exercise involves the collection of operational asset, system and financial data which is subsequently combined to produce business level key performance indicators. Transend's performance can then be benchmarked against other TNSPs both in the Australia/New Zealand region and across the world.

Typical outcomes from this benchmarking exercise include sharing best practice asset management regimes and identifying various aspects of Transend's maintenance practices that are either performing well or poorly in comparison with other similar TNSPs.

The improved automation of data collection, processing and reporting described earlier has assisted considerably in reducing the time taken to prepare the dataset for ITOMS.

In addition to ITOMS benchmarking, Transend also participates in the Electricity Transmission Network Owners Forum (ETNOF) benchmarking peer group. This group takes a proactive role in ensuring that benchmarking indices and definitions, including those used within ITOMS, are consistent and relevant so that meaningful comparisons can be made between the performance of TNSPs across Australia and New Zealand.

Transend will continue to keep abreast of advances in asset and system performance improvement and reporting initiatives not only through continued participation in these benchmarking exercises, but also through ongoing close cooperation and sharing of information with counterparts in other TNSPs.



Transmission System Development

Transend's overall capital program predominantly comprises of transmission system development (augmentation) and transmission system asset renewal (refurbishment, replacement and enhancement). The four key inputs to the development capital expenditure process are new customer connections, load forecasts, rules compliance and transmission network system security and planning criteria.

In conjunction with these inputs and in alignment with the network vision, Transend undertakes modelling and analysis in order to develop regional and integrated development plans.

Transend continues to develop its suite of documentation supporting the investment governance and project justification processes.

Chapter 4

Transmission System Development

4.1 Introduction

4.2 Key Development Drivers

4.3 Customer Management

4.4 Annual Planning Process

4.5 Load Forecasts

4.6 Rules Compliance

4.7 Transmission Network Security and Planning Criteria

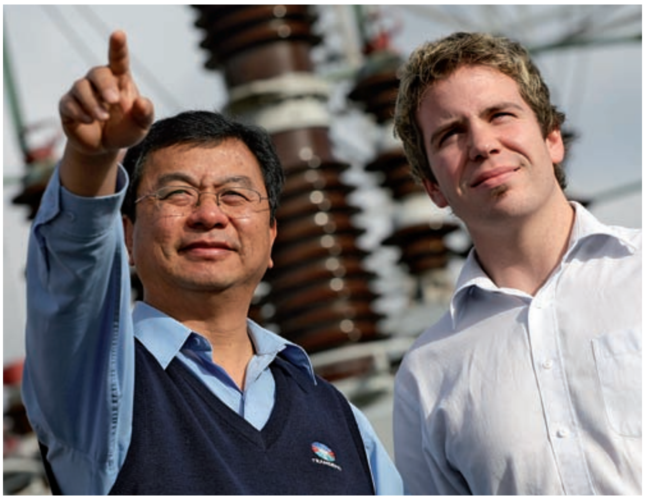
4.8 System Development Plan

4.9 Integrated Investment Plan

4.10 Investment Process Governance

4.11 Investment Evaluation

4. TRANSMISSION SYSTEM DEVELOPMENT



4.1 INTRODUCTION

This section discusses the drivers for the development of the transmission system. It also outlines the annual planning cycle that is undertaken to determine the transmission system developments necessary to meet future Tasmanian and national electricity supply requirements.

The projects identified required to meet Tasmanian and national electricity supply requirements are set out in the Annual Planning Report that is issued in compliance with NER and local jurisdiction requirements.

Transend's overall capital program predominantly comprises:

- Transmission system development (augmentation).
- Transmission system asset renewal (refurbishment, replacement and enhancement).

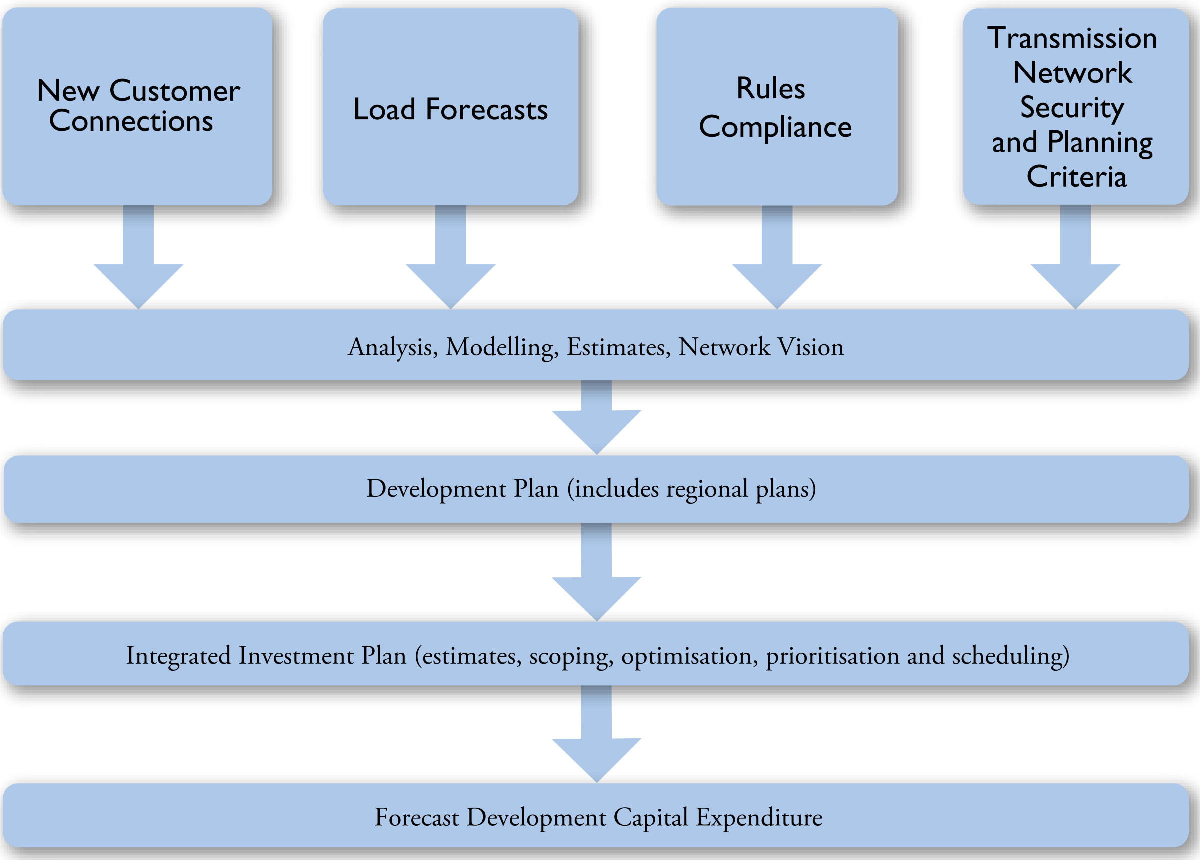
4.2 KEY DEVELOPMENT DRIVERS

The four key inputs to the development capital expenditure process are:

1. New customer connections.
2. Load forecasts.
3. Rules compliance.
4. Transmission network system security and planning criteria.

The development capital expenditure process is illustrated in Figure 4.1.

Figure 4.1 - Key drivers to development capital expenditure



4.3 CUSTOMER MANAGEMENT

In the context of this chapter, Transend's customers are those directly connected to the transmission system, or those planning to do so. Customers include generators, market network service providers, distributors, retailers and major industrials.

Striving to provide a quality service and creating value for customers is a key strategic objective for Transend. To meet this objective, Transend must work closely with customers to develop cost-effective solutions that meet the required connection point performance.

Transend also works closely with customers to plan for future load growth and with the review of the network vision.

4.4 ANNUAL PLANNING PROCESS

Transend has an obligation under the NER to undertake an annual planning review of the capability of the transmission network to meet forecast electricity demand requirements. The outcomes of the annual planning review process are documented in the Annual Planning Report (APR). The information presented is intended to assist industry participants and other interested parties to:

- identify locations that would benefit from supply capability or demand side management initiatives;
- identify locations where major industrial loads could be connected;
- understand how the transmission network affects them;
- assess the capability of the transmission network to transfer electrical energy; and
- provide input to the future development of the transmission system.

Information in the APR is, in part, based on the annual planning review meeting held between Transend and Aurora Energy Pty Ltd (Aurora) and the outcome of regular consultations with Aurora. The APR details:

- energy and demand forecast;
- transmission system constraints;
- committed, advanced or completed network developments;
- proposed network developments within five years; and
- other relevant technical information.

The report also summarises the following information about each planned development project:

- The basis for the development.
- The proposed solution.
- Timing of the development.
- An estimate of the cost.
- Network and non-network options considered.

The individual projects identified in the APR are subject to a rigorous approval process including the application of the regulatory test for augmentation of the network. Each project will also involve preparation of detailed individual business cases, and any required planning approvals, development applications or other external approvals.

Information from the APR enables NEMMCO to prepare the Statement of Opportunities (SOO). The SOO examines electricity supply and demand issues across all regions in the NEM. It determines the adequacy of NEM electricity supply to meet the projected electricity demand. It also contains the Annual National Transmission Statement (ANTS) which reviews national transmission flow paths, identifies any constraints that will arise in these flow paths and examines options to relieve those constraints.

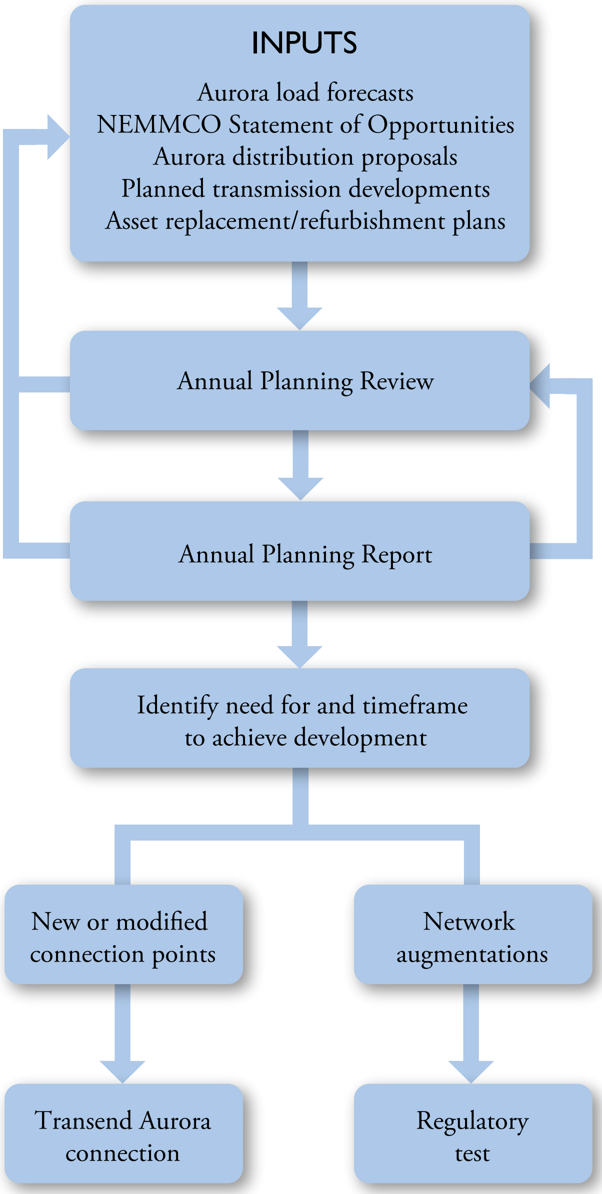
Transend is also required by the Tasmanian Energy Regulator to produce a Tasmanian Annual Planning Statement (TAPS). The purpose of the TAPS is to provide information about:

- The structure of the electricity supply industry.
- An overview of the Tasmanian electricity supply system and its ongoing development.
- Electricity supply system performance.
- Proposals for distribution connection point developments.

The 2007 APR includes all of the information required for the TAPS.

A flowchart detailing the annual planning process is illustrated in Figure 4.2 - Annual Planning Review process summary.

Figure 4.2 - Annual Planning Review process summary



4.5 LOAD FORECASTS

In planning future network augmentations, Transend must consider generation and load forecasts and customer connection enquiries.

Transend uses the services of the National Institute of Economic and Industry Research (NIEIR) to provide the econometric load forecast.

Load growth in the major industrial category is now not included in Aurora Energy load forecasts but Transend should be aware of any major industrial customer load increase through changes in the connection agreement with these customers.

4.6 RULES COMPLIANCE

Transend is also obligated to ensure the transmission system meets the technical performance criteria prescribed in the NER. These obligations include requirements for:

- Network reliability and stability (security).
- Power quality (voltage fluctuations, voltage waveform distortion, voltage unbalance).
- Frequency variations.
- Protection systems and fault clearance times.
- Ratings of transmission lines and equipment.
- Load and network control facilities.

4.7 TRANSMISSION NETWORK SECURITY AND PLANNING CRITERIA

The Reliability and Network Planning Panel (RNPP) of the Office of the Tasmanian Energy Regulator has recommended transmission network security and planning criteria which are 'performance-based'; that is they limit either the size of customer load that may lose supply in certain circumstances, or the length of interruption, or both. It is then left to Transend to determine the least-cost solution that satisfies the regulatory test. These criteria do not apply to energy-intensive customers connected directly to the transmission system as the level of security of their connection is negotiated with the customers and specified in their connection agreements.

The minimum network performance requirements are as follows and apply to the intact power system:

- No credible contingency event will interrupt more than 25 MW of load.
- No single asset failure will interrupt more than 850 MW or, in any event, cause a system black.
- The unserved energy to loads interrupted as a result of damage to a network element related to a credible contingency event must not exceed 300 MWh.
- The unserved energy to loads interrupted as a result of a single asset failure must not exceed 3 000 MWh.
- Where a network element has been withdrawn from service for replacement, maintenance or repair, the energy exposed to interruption by a credible contingency event must not exceed 18 000 MWh.

These recommended minimum performance requirements apply for the purpose of the classification of a proposed transmission augmentation as a reliability augmentation. Higher standards of performance requirements may be achievable in some instances under the market benefit limb of the regulatory test when the economic cost of interruptions to the relevant loads or load areas is particularly high.

4.8 SYSTEM DEVELOPMENT PLAN

Transend's planning and capital investment activities are strongly influenced by external agencies including the AER, OTTER and customers.

Transend augments the transmission system to cost effectively meet its obligations under the NER. Under the NER, Transend is obligated to analyse the expected and future operations of the transmission network over a 10-year planning period and to identify augmentation projects that address the identified deficiencies. The resulting network augmentation projects are then subject to a regulatory test.

In addition to meeting the requirements imposed by the NER, Transend must, under the conditions of its licence, plan, propose and procure augmentations required to meet service obligations including obligations imposed by jurisdictional planning criteria.

4.9 INTEGRATED INVESTMENT PLAN

Capital projects, together with operating and maintenance expenditure to maintain the assets, underpin Transend's transmission service delivery. To allow effective coordination and conduct of its works, Transend must develop an overall works plan, encompassing all projects with impacts on the transmission network.

The development plan and the asset management plans for the various asset classes are integrated (using AMIS tools and systems) to develop an integrated investment plan. This ensures that opportunities are identified to minimise expenditure. Where possible:

- asset renewals and maintenance at sites affected by augmentations are coordinated to minimise outages and rework;
- maintenance is not undertaken, or is scaled back, for assets which are to be replaced by augmented assets; and
- renewal and development expenditure project contracts are bundled to achieve scale efficiencies.

4.10 INVESTMENT PROCESS GOVERNANCE

Transend maintains an Investment Process Governance Framework that describes the governance structures guiding the consideration and determination of capital investment decisions within Transend.

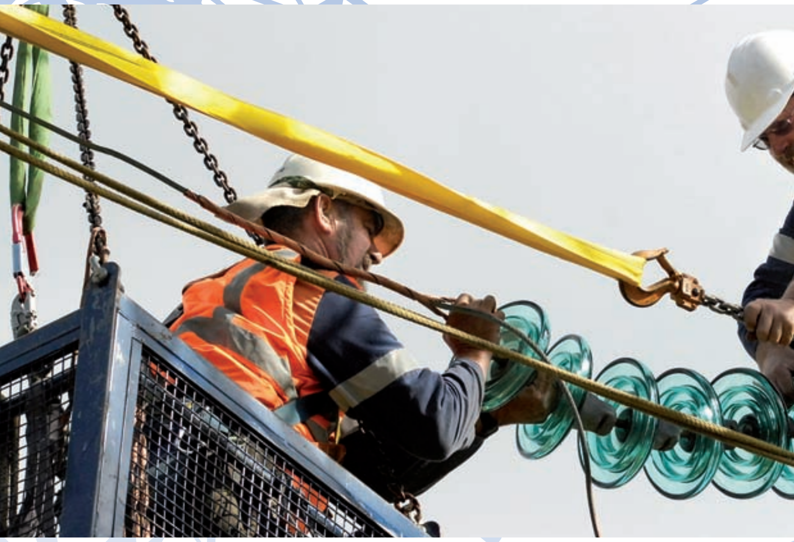
The framework demonstrates that Transend has in place and applies the required technical, managerial and financial governance processes to ensure:

- investments meet the company's mandated legal and regulatory obligations in a cost-effective manner and comply with the specific capital expenditure objectives and criteria stipulated in the rules;
- investments are aligned with justified development plans and strategies, provide a reliable electricity transmission service, add capacity efficiently to meet forecast load growth and cater for new connections to the network;
- the investment process is consistent with good electricity industry practice, undertaken using a collaborative and consultative approach with stakeholders and supported by documented policies, practices and procedures; and
- capital expenditure is prudent and results from a demonstrably prudent and efficient asset investment and management governance framework.

4.11 INVESTMENT EVALUATION

Documentation is being enhanced and developed to specify the steps required during the investment evaluation of projects involving transmission network assets. Guidelines are under construction to provide assistance to personnel involved in the justification of transmission network projects by:

- identifying the various types of network projects;
- identifying and defining the different steps that can possibly be taken in project justification;
- specifying the need for each of these steps for a project of certain types;
- providing guidelines as to how these steps can be implemented;
- identifying the inputs and outputs to various steps of project justification; and
- linking various existing systems, processes and tools used in the process; and providing a basis for consistency for future project justifications.



Existing Asset Profiles and Strategies

Transend owns a diverse range of assets of varying technology, complexity and age that operate in a wide range of service environments. These assets are classified into particular asset groups: substation primary assets, substation secondary assets which include protection, control and metering schemes, the transmission lines making up the EHV transmission network, telecommunications network and Supervisory and Data Acquisition Systems (SCADA).

Because of the complexity of its existing asset profile, Transend has identified a number of important issues and developed a range of corresponding replacement, refurbishment or maintenance strategies.

Transend has developed comprehensive asset management plans for all of these asset categories which include specific strategies to address identified safety, environment, performance, condition, design and capacity issues.

Formal risk management principles are applied in the development of these plans.

Chapter 5

Existing Asset Profiles and Strategies

5.1 Introduction

5.2 Substations

5.3 Substation Primary Assets

5.4 Substation Secondary Systems

5.5 Transmission Lines

5.6 Telecommunications and Supervisory and Data Acquisition Systems

5.7 Asset Disposal

5. EXISTING ASSET PROFILES AND STRATEGIES

5.1 INTRODUCTION

This section profiles the existing assets comprising the authorised transmission system including identification of some salient issues and corresponding replacement, refurbishment or maintenance strategies. The particular asset categories described are substation primary assets, substation secondary assets which include protection, control and metering schemes, the transmission lines making up the EHV transmission network, telecommunications network and Supervisory Control and Data Acquisition systems (SCADA).

5.2 SUBSTATIONS

5.2.1 Overview

Transend owns and operates 47 terminal substations and switchyards, nine switching stations and two transition stations as listed in Appendix C. Within this chapter the different types of stations are collectively referred to as substations.

Substation may include assets such as:

- Power transformers
- Circuit breakers
- Capacitor banks
- Disconnectors and earth switches
- Instrument transformers
(voltage and current transformers (CTs and VTs))
- Gas insulated (GIS) switchgear
- High voltage (HV) switchgear
- Power cables
- Surge diverters
- Structures and busbars
- Post insulators and insulator strings
- Earthing systems
- Protection, control and operational metering equipment
- Revenue metering equipment
- Ancillary plant
- Civil infrastructure

The substations operate at a range of voltages including 220, 110, 44, 33, 22, 11 and 6.6 kV. The diversity of make, type, age and technology of the equipment installed to support the wide range of operating voltages significantly increases the complexity of asset management. In particular, operations and maintenance management, contingency plans and spares policy are affected by the diversity.

Transend's approach to justifying operating and capital expenditure on substation assets is not driven by age but condition, however, generally older equipment is less reliable and requires more maintenance than modern equivalent assets.

5.2.2 Maintenance, refurbishment and replacement

In general, Transend's maintenance and capital program is based on asset condition and performance. The condition of equipment is monitored by staff on a routine basis and data analysed to determine appropriate action.

It is important to note that, over time, Transend's substation assets have increasingly been required to run closer to operating limits and for longer periods and this has required close monitoring and more frequent condition assessment of equipment subjected to these higher loadings. Operating the equipment in this manner can allow some deferment of substation augmentation, however, it can also be accompanied by higher risk.

Transend has developed comprehensive asset management plans for all asset categories which include specific strategies to address identified performance, condition, design and capacity issues. Formal risk management principles are applied in the development of these plans.

5.3 SUBSTATION PRIMARY ASSETS

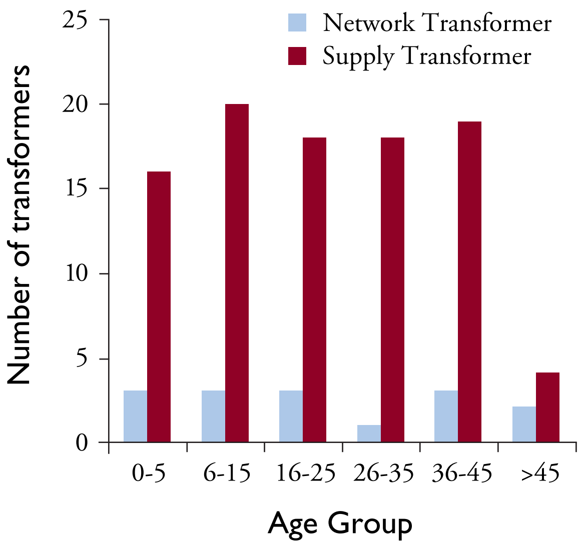
5.3.1 Power transformers

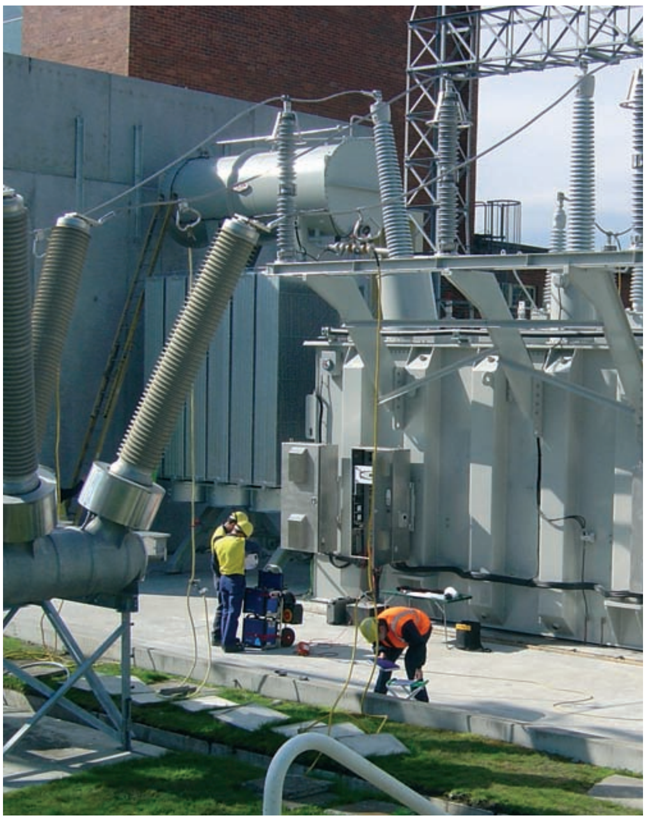
Transend has a population of 109 power transformers in service comprising 15 network transformers and 94 supply transformers (station service transformers are not included). Planned development projects will also result in one additional network transformer and 15 additional supply transformers by 2014. Power transformers are one of the most critical and the highest unit cost substation assets.

Network transformers are typically large capacity auto-transformers that interconnect the 220 kV and 110 kV transmission systems. Supply transformers are located at sites that supply either the distribution network or direct-connect customers. Supply transformers typically have a primary voltage of 220 kV or 110 kV and secondary voltages of 44, 33, 22, 11 or 6.6 kV.

The average age of Transend's network transformers and supply transformers is 24 years and 27 years respectively. Power transformers are considered to have an average service life of 45 years and there are currently 11 transformers exceeding this. The transformer age profiles are shown in Figure 5.1.

Figure 5.1 - Power Transformer Age Profile





The effective management of transformers is critical to sustaining a reliable electricity supply to customers. Transformer failures are costly, they can present significant safety and environmental risks and can take up to 12 months to repair or replace, depending on the nature of the fault. The application of condition assessment techniques consistent with industry best practice in conjunction with the proactive replacement of transformers that are likely to fail, limit the number of transformer failures. In the event of a transformer failure, having adequate contingency plans in place is critical to sustaining a reliable electricity supply to customers.

Issues

Key issues to be addressed in managing Transend's power transformer population include:

- Age profile: The next five years will see a significant increase in the number of transformers exceeding a service life of 45 years if no action is taken to replace units. While age is not the predominant driver for asset replacement decisions, it is important to recognise that the probability of failure for a transformer increases significantly towards the end of its service life.
- Obsolete design leading to reliability and maintenance issues: The most significant issue is the diverse nature of the supply transformer population which varies widely in winding configuration, impedance and capacity. This diversity increases the complexity of life cycle asset management and contingency planning. It also requires the retention of a large proportion of spare supply transformers in comparison to the total supply transformer population.
- Poor condition of a significant number of transformers and ancillary equipment.
- The high number of power transformers for which no suitable spare exists.

Strategies

Transend's strategies to manage its power transformer population include:

- A transformer replacement program: A significant number of older transformers that are in poor condition will be replaced over the next 10 years. In addition, a number of transformers have been identified for replacement based on their insufficient capacity to meet forecast load growth.

  The program includes replacement of four network transformers and 24 supply transformers. Following implementation of the proposed 10-year program, the number of transformers exceeding 45 years will reduce to a total of four by 2016.

- Development of standard transformer technical specifications: Transend has developed comprehensive standards for network and supply transformers and aims to standardise the characteristics and components of the transformers (impedance, winding configuration, capacity, bushings, tap-changers etc) as far as practicable.

  The use of low-maintenance vacuum-type tap-changers is also being trialled with supply transformers. This type of tap-changer will significantly reduce the life cycle management costs for supply transformers.

- Environmental: For the past seven years, Transend has had a program in place to address oil containment deficiencies. All substations are now equipped with contemporary oil containment systems that have included catchpits, oil containment tanks, oil/water separator, interconnecting pipework and blastwalls for fire containment. Ten substations are undergoing replacement of temporary bunding ('hypalon' systems).

Transend has completed a program to determine polychlorinated biphenyls (PCB) levels within its power transformer population. Only low-level contamination has been detected in some transformers.

Noise reduction: Transend's approach to the issue of noise generated by power transformers, has been one of prudent avoidance. However, Transend continues to monitor noise within and around substation sites to establish noise levels to be able to respond to any community concerns

- **Maintenance and condition assessment:** Transend applies a regime of regular inspections and non-intrusive condition assessment techniques to ascertain the condition of its power transformers. Performing intrusive maintenance on power transformers is only undertaken when necessary because it is costly and requires long outages for the work to be undertaken.

  Limited on-line condition monitoring equipment capable of remote interrogation is being installed on selected transformers, together with consideration of the use of in-service oil conditioning equipment.

- **Transformer overhaul:** Overhaul of power transformers is undertaken where condition assessment identifies the need to avoid failure and to sustain their ongoing serviceability. Test results for power transformers and industry experience have shown that overhaul of transformers is normally required after 20-30 years (or 'mid-life') of service. However, Transend continues to follow its policy of conducting overhauls only if the condition assessment results of a particular power transformer indicate the need and that the overhaul will provide a life cycle benefit.

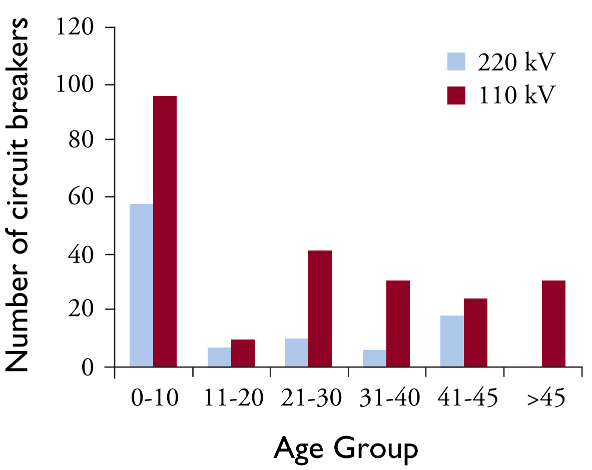
5.3.2 Circuit breakers

This section covers 110 kV and 220 kV circuit breakers. Transend has both small oil volume and SF_6 gas-filled live-tank circuit breakers and SF_6 gas-filled dead-tank circuit breakers with integral current transformers (CTs).

Asset management aspects of circuit breakers associated with extra high voltage (EHV) gas-insulated switchgear (GIS) installations are covered separately.

Transend has a population of 310 circuit breakers in service, including 231 units operating at 110 kV and 79 units at 220 kV. Circuit breakers are regarded as having an average service life of 45 years. The average age of Transend's circuit breaker population is 21 years as at June 2007. The average age for 220 kV and 110 kV circuit breakers is 12 and 23 years respectively. The age profile of Transend's EHV circuit breakers is shown in Figure 5.2.

Figure 5.2 - Circuit Breaker Age Profile



The relatively low average age is largely a result of Transend's circuit breaker replacement program, which has resulted in the replacement of 117 units over the past 10 years. In addition, 45 new circuit breakers have been installed as part of transmission system developments over the past 10 years. Given the relatively low average age of Transend's circuit breakers, overall performance levels of the population should not be adversely affected by age-related issues. However, the results from the International Transmission Operations and Maintenance Study (ITOMS) conducted in 2005 indicate that Transend's EHV circuit breaker population, on average, is up to five years older than most other participants in the study. The circuit breaker replacement program is predominantly aimed at replacing the units that are older than 45 years of age because of their maintenance intensive design, resulting in a reduction in the average age of the circuit breaker population.

Issues

Key issues to be addressed in managing Transend's circuit breaker population include:

- Significant design, condition and performance issues leading to reliability and maintenance issues, particularly with certain types.
- Oil management and compliance issues.
- Lack of specialised local service providers to undertake maintenance and repairs.
- Lack of standardisation throughout the circuit breaker population and spares unavailability. Transend's population of circuit breakers includes units constructed by ten manufacturers comprising 26 different types. Condition monitoring results for each of the types vary substantially as different design and construction methods are used. Of the 26 types currently in service, 14 have a population size of less than 10 units, which considerably restricts the ability to establish meaningful trends in condition monitoring data.

  In addition to condition monitoring issues, the difference in physical design and construction characteristics between types increases the complexity of contingency planning and spares management issues.
- There are 30 units that exceed the average service life for circuit breakers, with a further 24 units approaching the end of their expected life.

Strategies

Transend's strategies to manage its circuit breaker population include:

- A program to replace specific circuit breaker types that are unreliable or present life cycle management issues. Where technically feasible, all new circuit breakers are procured to a standard specification. Gas insulated dead tank circuit breakers are used at all locations that do not require Single-Pole Auto-Reclose (SPAR) or point-on-wave switching capability.
- Transend has developed programs to mitigate the risks associated with possible PCB contamination in oil-filled units and for SF_6 gas management.
- Maintenance standards have been developed for each circuit breaker type. Plans include set intervals for condition monitoring, routine inspections and each class of maintenance. The frequency of condition assessment largely depends on type and the duty to which a circuit breaker is subjected.

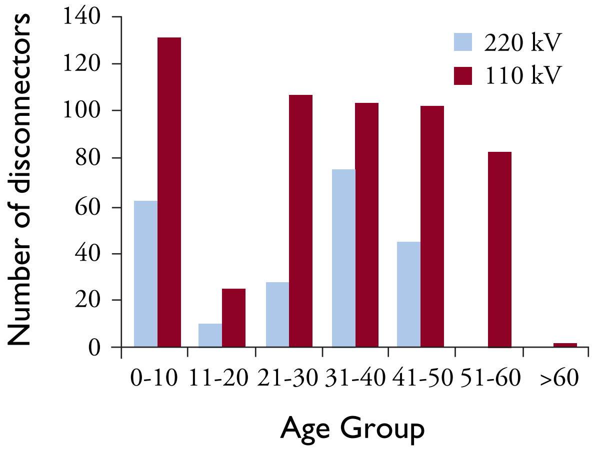
5.3.3 Disconnectors and earth switches

Transend has 767 EHV disconnectors (550 at 110 kV and 217 at 220 kV) currently in service. In addition, Transend also has 323 earth switches (223 at 110 kV and 100 at 220 kV) attached to disconnectors. Predominantly the disconnectors are manually operated, with an exception of 68 disconnectors that are motorised and capable of being operated remotely. With new network developments the number of motorised disconnectors is expected to increase. Only three disconnectors in Transend's population are load-break type.

The average age of Transend's 110 kV and 220 kV disconnector populations are 29 years and 28 years respectively. Fifteen per cent of 110 kV disconnectors have past their expected service life of 50 years. More than a third of the 110 kV population is older than 40 years. There are no 220 kV disconnectors more than 50-years-old however 20 per cent are currently beyond 40-years- old.

The age profile for Transend's disconnector population is shown in Figure 5.3.

Figure 5.3 - Disconnector Age Profile



Transend's disconnector population includes units constructed by 13 manufacturers comprising 39 different manufacturer types. Of these types, 23 have a population of less than 20 units, which adds complexity to spares management and maintenance practices for the different design types.

Issues:

Key issues to be addressed in managing Transend's disconnector and earth switch population include:

- Poor condition of a number of 110 kV disconnectors.
- An additional 257 disconnectors have reached, or are approaching, the end of their useful service lives.
- Obsolete design leading to reliability and maintenance issues, particularly with certain types.
- A substantial number of units no longer have manufacturer support.
- The large number of disconnector types necessitate considerable spares management and maintenance effort.
- The large number of disconnectors that cannot be operated remotely can cause delays in the restoration of electricity supply.
- The status of many earth switches are not returned to local SCADA or the Network Operations Control System (NOCS).
- A number of installations without earth switches contrary to good industry practice.

Strategies

Transend's strategies to manage its disconnector and earth switch population include:

- A disconnector replacement program has been in place since 1999 to address design, reliability and performance issues and high maintenance and repair costs associated with the disconnector population.

  The program recommends that 87 disconnectors be replaced by 2014. In addition, the program will rationalise the number of disconnector types and designs through equipment standardisation, enabling more efficient maintenance practices, a reduction in the disconnector spares inventory and simplified contingency planning and fault response process.
- Refurbishment of 77 disconnectors in the population over the next seven years.
- A need has been identified to install earth switches on eight transmission line or bus coupler disconnectors in the transmission system.
- Changes to substation design philosophy have led to plans to reduce the disconnector population. With the proposal to convert three existing substations to GIS switchyards and with the continuation of circuit breaker replacements, 93 disconnectors have been identified for decommissioning over the next seven years. Further bypass disconnectors will be decommissioned into the future with the continuation of the dead-tank circuit breaker installation policy.
- A recommendation has been made to continue the retro-fitting of disconnectors for motorised operation and installing new units with motorised operation. This will allow remote operation of disconnectors utilised for bus selection of transmission lines, transformers and circuits connected to generation.

- Disconnector maintenance: Asset replacement is the most cost-effective option to address the vast majority of performance issues with disconnectors.

Maintenance standards have been developed for each disconnector and earth switch type. Plans include set intervals for condition monitoring, routine inspections and each class of maintenance. The frequency of condition assessment largely depends on the design of the disconnector.

5.3.4 Current transformers

This section includes asset management aspects of 110 kV and 220 kV post-type current transformers (CTs) only.

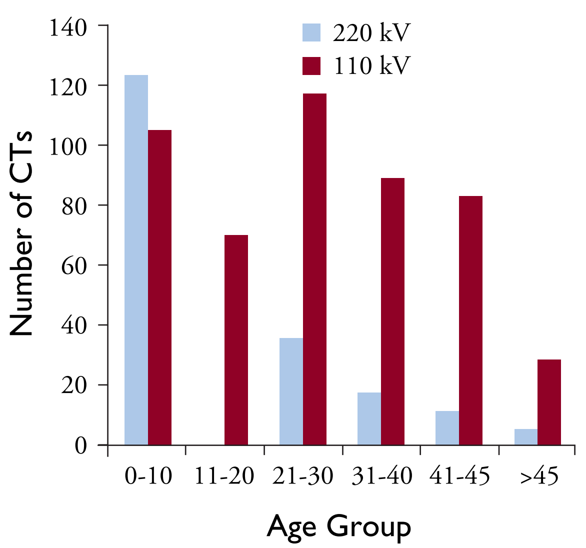
Transend has 688 post-type CTs currently in service comprising 493 units operating at 110 kV and 195 units at 220 kV.

The post-type CTs are categorised based on the insulating medium adopted. The categories include:

- Oil-filled current transformers (620 units).
- SF_6 gas-filled current transformers (68 units).

CTs have an average service life of 45 years. The average age of Transend's CT population is 24 years as at June 2007. The population includes 36 units that exceed the average service life. The mid-life average age is balanced by the large numbers of newer 220 kV CTs and a large number of older 110 kV units. Given the relatively low average age of Transend's 220 kV CTs, the performance levels of the population should not be significantly affected by age-related issues. For the 110 kV current transformer population, age-related issues are more likely. The age profile of Transend's CT population is shown in Figure 5.4.

Figure 5.4 - CT Age Profile



Transend's population of CTs includes units constructed by 15 manufacturers comprising 53 different types. Condition-based techniques are applied consistently across the CT population, however the defect results vary substantially as different design and construction methods are used for each type. Of the 53 types of CTs currently in service, 35 have a population size of less than 20 units, which considerably restricts the ability to establish meaningful trends in condition monitoring data for each of these types. In addition to condition monitoring issues, the difference in physical design and construction characteristics between types presents contingency planning and spares management issues.

Issues

Key issues to be addressed in managing Transend's post-type CT population include:

- Design issues for specific types including inadequate hermetic sealing to prevent moisture ingress and the lack of oil sampling ports for condition monitoring.
- More than 120 CTs have reached, or are approaching, the end of their service lives. The probability of failure for a CT increases significantly towards the end of its service life.
- Insufficient secondary windings to meet NER compliance obligations for some CTs.
- Management of oil or gas leaks.
- Lack of standardisation throughout the CT population.

Strategies

Transend's strategies to manage its CT population include:

- A CT replacement program is in place to address design, reliability, performance and standardisation issues and high maintenance and repair costs associated with the CT population. The program also identifies the decommissioning of 274 110 kV CTs by 2014 in conjunction with Transend's circuit breaker replacement program. The circuit breaker replacement strategy includes the use of dead tank circuit breakers with integral current transformers where appropriate, which will result in the decommissioning of a significant number of 110 kV post-type current transformers over the next seven years.
- The replacement of 12 CTs operating at 220 kV approaching, or at the end of their service lives is likely in conjunction with other planned capital works. The units also require replacement because they do not comply with NER requirements.
- Condition assessment and maintenance practices for current transformers have been revised where appropriate to improve reliability. The adoption of innovative asset management techniques, including dissolved gas analysis, will substantially reduce current transformer average annual preventive maintenance.
- The following specific programs are being developed and implemented:

  Dissolved Gas Analysis (DGA) program

  DGA provides a more accurate means of assessing asset condition and is substantially lower in cost compared with electrical testing. In addition, the duration of a transmission circuit outage to take an oil sample is considerably lower than electrical testing methods.

  PCB testing program

  Transend will continue its program to determine the PCB levels within the current transformer population to mitigate the risks associated with PCB contamination.

  - Accuracy testing of current transformers used for wholesale metering purposes is undertaken in accordance with NER requirements.

5.3.5 Voltage transformers and coupling capacitors

This section covers all post type 110 kV and 220 kV voltage transformers (VTs) and coupling capacitors.

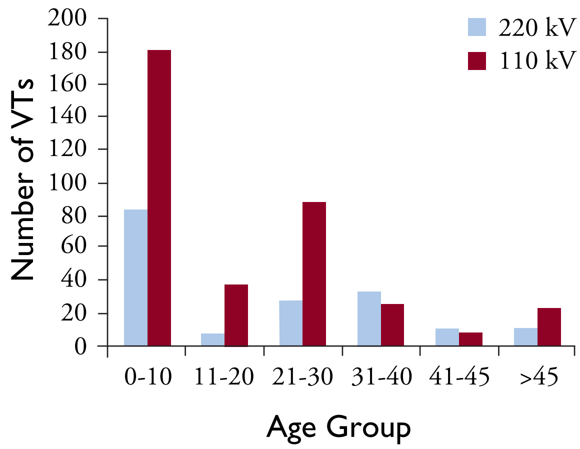
Transend has in service 530 EHV free-standing VTs and 13 coupling capacitors operating at 110 kV. Transend's VTs can be categorised based on the insulating medium and design principle adopted. The categories include:

- Oil-filled capacitive voltage transformers (CVTs) (229 units).
- Oil-filled inductive voltage transformers (203 units).
- SF_6 gas-filled inductive voltage transformers (98 units).

Voltage transformers are considered to have an average service life of 45 years. The average age of Transend's VTs is 19 years as at June 2007. The population includes 33 units that exceed the average service life. The relatively low average age profile is largely a result of Transend's transmission line voltage transformer installation program, which has resulted in the installation of approximately 81 new voltage transformers over the past five years. Given the relatively low average age of Transend's voltage transformers, overall performance levels of the population should not be adversely affected by age-related issues.

The age profiles for VTs are shown in Figure 5.5.

Figure 5.5 VT Age Profile



The population of voltage transformers includes units constructed by 16 manufacturers comprising 32 different types. Condition monitoring results for each of the types can vary substantially as different design and construction methods are used for each type. Of the 31 types of voltage transformers currently in-service, 23 have a population size of less than 20 units, restricting the ability to establish meaningful trends in condition monitoring data for each type and also increasing the complexity of contingency plan and spares management.

Issues

Key issues to be addressed in managing Transend's VT and coupling capacitor population include:

- Design issues for specific types including inadequate hermetic sealing to prevent moisture ingress and the lack of oil sampling ports for condition monitoring.
- Poor electrical condition of a number of 110 kV VTs.
- More than 130 VTs have reached, or are approaching, the end of their service lives.
- Management of oil or gas leaks.
- Design and operational issues associated with VT selection schemes at substations that do not utilise VT on transmission line circuits.
- Lack of standardisation throughout the VT population.

Strategies

Transend's strategies to manage its VT and coupling capacitor population include:

- Established programs to replace specific voltage transformer and coupling capacitor types that are unreliable or present life-cycle management issues. Assessment of the VT population proposes the replacement of 54 220 kV units and 83 110 kV units over the next seven years. Replacements will take place in conjunction with other planned capital works where possible.
- The use of standardised capacitive voltage transformers (CVTs) to reduce life cycle maintenance costs and mitigate the risk of a major failure of a VT. The on-line phase voltage measurement method can be applied to CVTs for continuous condition monitoring, enabling early detection of deterioration.
- An established program to install dedicated VTs on critical transmission lines, to minimise the likelihood of interruption to electricity supply.
- A variety of condition assessment methods to determine voltage transformer electrical condition. The methods include:
    - High voltage electrical testing.
    - Oil sampling and dissolved gas analysis (DGA).
    - Sulphur hexafluoride (SF_6) gas sampling and analysis.
    - Online phase voltage measurement.
    - Accuracy testing of voltage transformers used for wholesale metering purposes is undertaken in accordance with NER requirements.

5.3.6 Capacitor banks

Transend has a total of 13 capacitor banks in service with an installed capacity of 385 MVAr. The banks have been progressively installed at 220, 110, 22 and 11 kV since the first 110 kV installation in 1996. A program continues to install a further 80 MVAr of capacitors at 22 kV and 11 kV in the transmission network.

In the relatively short time in service of Transend's capacitor banks, no apparent inherent problems have been indicated.

Transend is currently considering a project to replace reactors and add additional capacitor cans at both Risdon and Lindisfarne substations to address power quality issues.

5.3.7 Gas Insulated Switchgear

Transend has one installation of 110 kV indoor gas insulated switchgear (GIS) at Risdon Substation which was installed in 2002. However, further installations are planned.

Condition monitoring and routine maintenance procedures are carried out in accordance with the manufacturer's recommendations and will be reviewed as condition assessments might indicate over time.

5.3.8 High Voltage (HV) switchgear

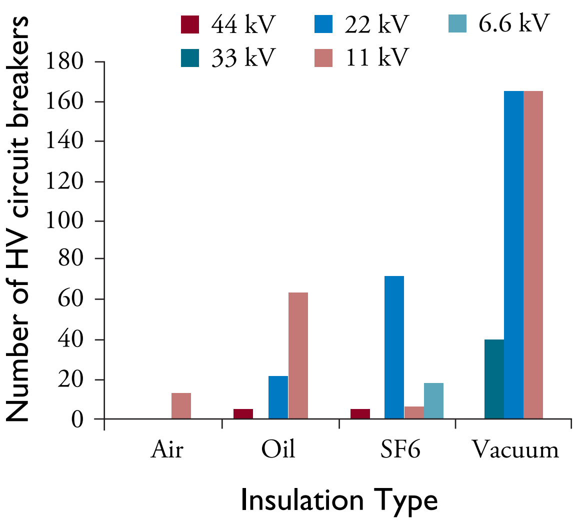
HV switchgear is located in a number of Transend substations that connect to the distribution network and in some cases, directly to major industrial customers. The HV switchgear includes busbars, circuit breakers, disconnectors, earthing switches, instrument transformers, supporting structures, cubicles and cable terminations.

Transend has high voltage systems operating at 44 kV, 33 kV, 22 kV, 11 kV and 6.6 kV but predominantly at 11 kV and 22 kV and totalling 505 HV circuit breaker bays.

The HV switchgear falls into two categories–outdoor type and indoor (mostly metal-clad) type. There are 20 outdoor switchbays and 505 indoor switchbays.

Figure 5.6 shows the breakdown of various insulation types of HV switchgear in the system.

Figure 5.6 - HV Switchgear Insulation Types



The average age of outdoor switchgear bays is 34 years, while the average age of indoor switchgear is 11, with both average ages reducing substantially due to a switchgear replacement program. The useful life of HV switchgear varies with the technology, with older equipment generally having a shorter life due to technology limitations.

Issues

Key issues to be addressed in managing Transend's HV switchgear include:

- Obsolete design leading to reliability and maintenance issues, particularly with certain types.
- Lack of spares and manufacturer support for old switchgear.
- Substandard safety clearances for outdoor switchgear.

Strategies

Transend's strategies to manage its HV switchgear include:

- Generally, outdoor HV switchgear is replaced, with indoor metal-clad switchgear. A replacement program has been in place for some years to address design, reliability and performance issues and high maintenance and repair costs.
- Strategies and maintenance practices for outdoor switchgear are similar to those for EHV equipment. Accuracy tests of CT and VT units utilised for metering are performed to meet NER requirements. Condition monitoring and routine testing is undertaken in accordance with the maintenance standards for the particular switchgear. Where increasing insulation deterioration is identified, more frequent monitoring is carried out until repair or replacement is warranted.
- Condition-based maintenance practices for indoor switchgear include the performance of circuit breaker timing tests to check the operating mechanism.

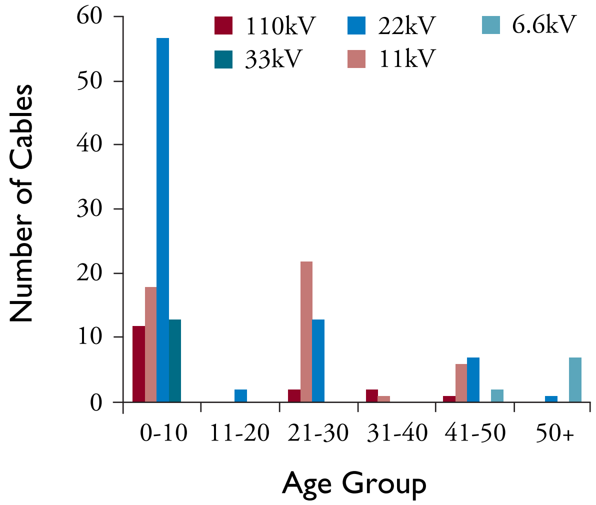
5.3.9 Power cables

Transend has 105 power cable circuit sections in service consisting of nine circuits at 6.6 kV, 47 at 11 kV, 80 at 22 kV, 13 at 33 kV and 16 circuits at 110 kV. The issues and strategies applied to cable circuits are the same irrespective of whether they comprise transmission line sections or the electrical connections between plant within substations and all are addressed in this section.

While the circuit lengths of power cable are relatively short, their location and function, irrespective of voltage level, is such that a cable failure can potentially lead to major disruption of supply.

The predominant insulating medium is cross-linked-polyethylene (XLPE) (92 cable sections) covering HV and EHV installations. Figure 5.7 shows insulant breakdown by voltage.

Figure 5.7 Power Cable Age Profile



All 110 kV cables have performed reliably to date and are considered to be in reasonable condition.

Transend's population of cables includes units constructed by nine manufacturers and a further 42 cable installations for which the manufacturer is unknown.

Condition monitoring results for each cable type can vary substantially as different design and construction methods are used for each type. Of the nine types of power cables currently in service, seven have a population size of less than ten units, which considerably restricts the ability to establish meaningful trends in condition monitoring data for each of the power cable types (see Figure 5.7).

Issues

Key issues to be addressed in managing Transend's power cables include the following:

- failures have been experienced with lead-sheath and paper-insulated cables and leaking compound-filled terminations. Failures of more modern heat-shrink cable terminations have been experienced due to poor workmanship and cable box moisture ingress;
- differences in physical design and construction characteristics between installations increases the complexity of contingency planning and spares management;
- a large number of power cables within substations are operating at 33 kV, 22 kV, 11 kV and 6.6 kV to supply indoor switchgear from supply transformers, most of which are of the lead-sheathed paper-insulated type varying in age from 16 to 40 years. A significant proportion of these are of unknown manufacturer;
- a shortage of suitably qualified and skilled jointers of EHV oil filled cables; and
- lack of spares and manufacturer support.

Strategies

Transend's strategies to manage its power cables include:

- a power cable replacement program predominantly aimed at replacing the units that are older than 40 years of age because of their obsolete design. The plan recommends that one 110 kV cable and 18 HV cables be replaced by 2014. The nominated replacements will reduce the average power cable age to well below 20 years in the planning period. Where practicable, power cable replacements will be coordinated with other substation upgrade works;
- all new and replacement HV cables to be of the XLPE type;
- rationalisation of the number of power cable types and designs through equipment standardisation, enabling improved use of condition monitoring data, a reduction in power cable spares inventory and simplified contingency planning and fault response processes;
- maintenance of adequate spare cable and termination/joint kits to repair failed cables
- the adoption of a collaborative approach with other TNSPs and/or establish agreements for service provision on a retainer basis with organisations with the capability to carry out specialised cable jointing and repair; and
- a variety of condition assessments to determine power cable electrical condition using a combination of condition monitoring selected on the basis of the specific types of cable. The methods include:
  - High voltage electrical testing including sheath insulation tests.
  - Oil sampling and dissolved gas analysis (DGA).
  - Gas pressure monitoring.
  - Online distributed temperature sensing (DTS).

5.3.10 Surge diverters

Transend has 355 extra high voltage surge diverters. These are located at the terminals of power transformers and cable terminations where there is the possibility of transient voltage surges due to lightning or switching. There are a smaller number of similarly located HV units.

The average age of 220 kV and 110 kV units is 13 and 15 years respectively. Transend has completed a program to replace silicon-carbide-gap type surge diverters, which were prone to explosive failure, with gapless metal-oxide units.

Currently, there are no identified issues associated with surge diverters.

Where replacement HV switchboards are installed, consideration has been given to locating surge diverters within feeder cable compartments.

5.3.11 Busbars and structures

A range of structural components is used in Transend's substations. These include large structures for outdoor electrical busbars and transmission line terminations, and smaller support structures for post insulators, instrument transformers, disconnectors and circuit breakers etc, which reflect evolving design standards and practices over many years.

Aluminium or copper conductors and fittings also provide electrical connections between assets within a substation.

The condition of bus bars and structures is heavily dependent on structural design and service environment. A number of substations are exposed to salt-laden winds and industrial contamination.

Issues

Key issues to be addressed in managing Transend's busbars and structures include:

- Instances of unacceptably high resistances of the connections between the conductor and bolted terminal clamps.
- Instances of string insulators supporting the overhead busbars being in poor condition.
- Corrosion of steel structures due to stray earth currents and exposure to salt-laden winds and pollution.
- Outdoor HV busbars are exposed to faults from wind blown debris or animals.

Strategies

Transend's strategies to manage its busbars and structures include:

- outdoor HV busbars will be replaced with indoor HV switchboards where practicable;
- where strung EHV busbars are replaced, consideration will be given to the application of tubular aluminium bus bars;
- bolted terminal clamps are obsolete technology, modern practice is to use compression fittings. Bolted terminal clamps will be progressively replaced with compression fittings, based on risk and criticality;
- routine condition assessment and maintenance practices include:
    - structures and bus works are subject to routine inspections as per the substation inspection schedule.
    - thermal imaging is to be conducted as per the substation thermal imaging program.
    - busbar structures are maintained or repaired as required.

Substation structures face similar issues to transmission line structures and these are discussed in more detail in the following transmission lines section.

5.3.12 Insulators

Substation insulators comprise string insulators and fee-standing post insulators. String insulators face the same issues as transmission line insulators and these are discussed in the following transmission lines section. This section profiles post insulators.

There are more than 6 700 EHV post insulators in Transend's substations with an average age of approximately 23 years as at June 2007. Post insulators are regarded as having an average service life of 50 years.

Issues

Key issues to be addressed in managing Transend's post insulators include:

- Poor electrical condition of approximately 1500 110 kV and 580 220 kV post insulators.
- Inherent design deficiencies associated with multi-piece post insulators which have resulted in a number of major mechanical and electrical failures in the past 10 years. The consequences of failure have ranged from considerable disruption to electricity supply, to the requirement for unplanned outages to facilitate replacement of the post insulators and the potential for serious injury to personnel.
- Exposure to high levels of pollution at some sites which can result in deterioration of the porcelain glazing.

Strategies

Transend's strategies to manage its post insulators include:

- Continuation of the post insulator replacement program to address design, condition and performance issues. It is recommended that over 1 400 110 kV units and around 529 220 kV units be replaced over the next seven years. Prioritisation of the replacement is based on the condition of the post insulator and its criticality to the power system. Where practicable, post insulator replacements will be coordinated with other substation works.
- Standardisation on the use of reliable, solid-core porcelain post insulators. In addition, Transend only uses post insulators that have a history of proven service within Australia for at least three years.
- Regular condition monitoring and preventative maintenance to be carried out, including visual inspections, thermal imaging and insulator washing in high-pollution areas. Based on condition assessment, the frequency of maintenance intervals may increase towards the end of a post insulator's life.

5.3.13 Earthing systems

Earthing systems within substations comprise underground earth grids, overhead earth-wires and lightning masts.

The earthing system is required to constrain earth potential gradients to safe levels under normal or fault conditions and during lightning strikes and provides common earth bonding for electrical equipment and metallic structures. It facilitates correct operation of electrical protection under fault conditions and minimises interference to control and telecommunications equipment.

To ensure safety of personnel, minimisation of damage to Transend or third party property and adherence to statutory obligations, substation earthing systems are inspected, current injection tested, maintained and augmented where necessary, on a routine basis.

5.3.14 Ancillary plant and systems

All substations contain ancillary plant and systems such as batteries and chargers, control and protection cabling, security systems, fire protection equipment, air conditioning and light and auxiliary power, all of which are monitored and refurbished or replaced as required.

Direct Current supply systems

Direct current (DC) supply systems are installed in all substations to power critical supervision, control, protection and metering equipment including circuit breaker trip and close supplies and other ancillary functions such as emergency lighting, security and fire detection systems.

Transend has a number of substations with single battery and DC supply systems and a prioritised program of implementing duplicate DC supplies is being coordinated with other works programs to eliminate obsolete equipment and substandard installations. DC systems that present a safety risk are also being replaced as a priority under the established program and battery chargers and other critical components that are obsolete and do not have adequate manufacturer/spare parts support will also be replaced.

Where appropriate, aged and deteriorated wiring at some sites is factored into replacement and refurbishment programs.

Routine condition assessment and maintenance practices include inspections and condition monitoring and discharge tests as appropriate.

5.3.15 Grounds and buildings

With 58 substations, the management of grounds and buildings is a major undertaking, particularly with the need to comply with all the relevant regulations, acts and codes. To ensure ongoing compliance and to meet Transend's needs as sites are augmented or redeveloped, various programs are in place for routine maintenance refurbishment or replacement.

5.4 SUBSTATION SECONDARY SYSTEMS

5.4.1 Overview

Substation secondary systems include the assets for protection, control, metering, monitoring, instrumentation and SCADA applications within substations.

Protection of the Tasmanian power system is challenging with a highly interconnected transmission system and complex interfaces with customers' assets. Complex integrated protection and control systems are required to operate the transmission system safely and within prescribed parameters. In addition, specific schemes such as:

- Special protection schemes
- Under frequency load shedding
- Under voltage load shedding
- Over frequency generator shedding schemes

are also required. More recently this involves implementation of a statewide System Protection Scheme (SPS) to manage the network voltage and frequency control. The purpose of these schemes are twofold: to protect transmission assets from being overloaded and to ensure the transmission system remains in a secure operating state following power system events.

Some similar protection schemes are built within the central Network Operation Control System (NOCS). These schemes can be temporary (to facilitate outages for any augmentation or maintenance works) or permanent (when information from multiple stations is required as an input for assessment of the power system and determination of the most suitable action to be taken).

The bulk of secondary assets are conventional secondary systems installed at either the bay or substation level. Table 5.1 defines the main secondary system categories.

A bay scheme is a collection of secondary devices dedicated to a particular asset located in a bay identified by a bay identifier. This will normally have a direct relationship to a single circuit, eg a transmission line.

A station scheme is a collection of secondary devices associated with multiple bays or multiple circuits.

Control schemes in substations comprise the local facilities to enable control and supervision of the primary equipment both by manual initiation and automatic systems. The protection schemes are an intrinsic part of a station control scheme. Most Transend substations are provided with RTUs which interface with the local control and supervision equipment to provide remote SCADA.

The dominant trend in secondary systems is toward the development and application of digital technology devices and systems with in-built intelligence and integrated functionality.

Transend's substation secondary assets are constantly being upgraded. The technology applied for secondary systems has seen a dramatic change over the past 20 years. There has been a shift from traditional electromechanical devices to modern, multifunctional, self monitoring microprocessor devices.

Table 5.1 - Secondary Scheme Categories

Scheme	Bay/Station	Description
EHV Transmission Line	Bay	110 kV, 220 kV transmission lines
EHV Bus Bar	Bay, Station	EHV Bus Zone and Bus Couplers
Transformer	Bay	Supply, network transformers
Capacitor Bank	Bay	EHV, HV Capacitor Banks
HV Substation	Bay, Station	HV Feeders, Bus Couplers, Bus Zone and Station Services transformers
SCADA	Station	Substation SCADA
Communications	Station	Communications
Monitoring Schemes	Bay, Station	Metering, Fault Location, Disturbance Recording
System Protection Schemes	Station	System Protection

Figure 5.8 profiles Transend's secondary device assets in terms of technology type and scheme category.

Secondary devices have expected service lives of:

- 40 years for electromechanical devices.
- 20 years for static devices.
- 15 years for microprocessor devices.

The shorter life span for microprocessor devices is attributed to firmware revisions and the limited time that manufacturers maintain stocks of spare components for these devices.
Figure 5.9 profiles Transend's secondary equipment by age.

Figure 5.8 - Relay Quantities by Category and Technology

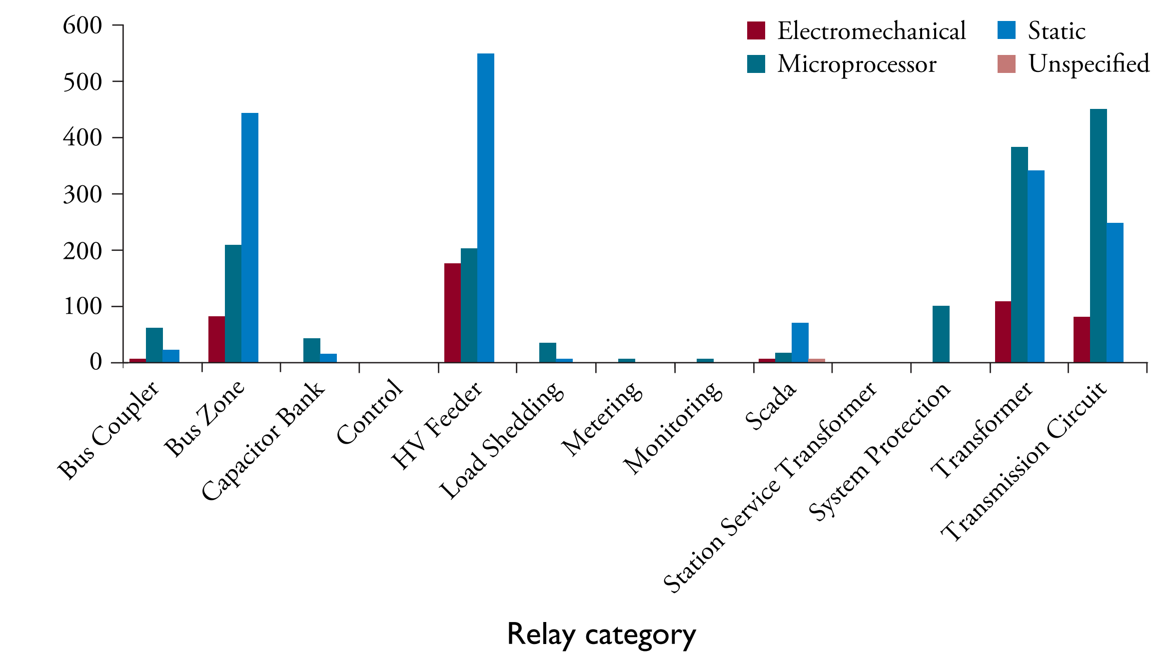
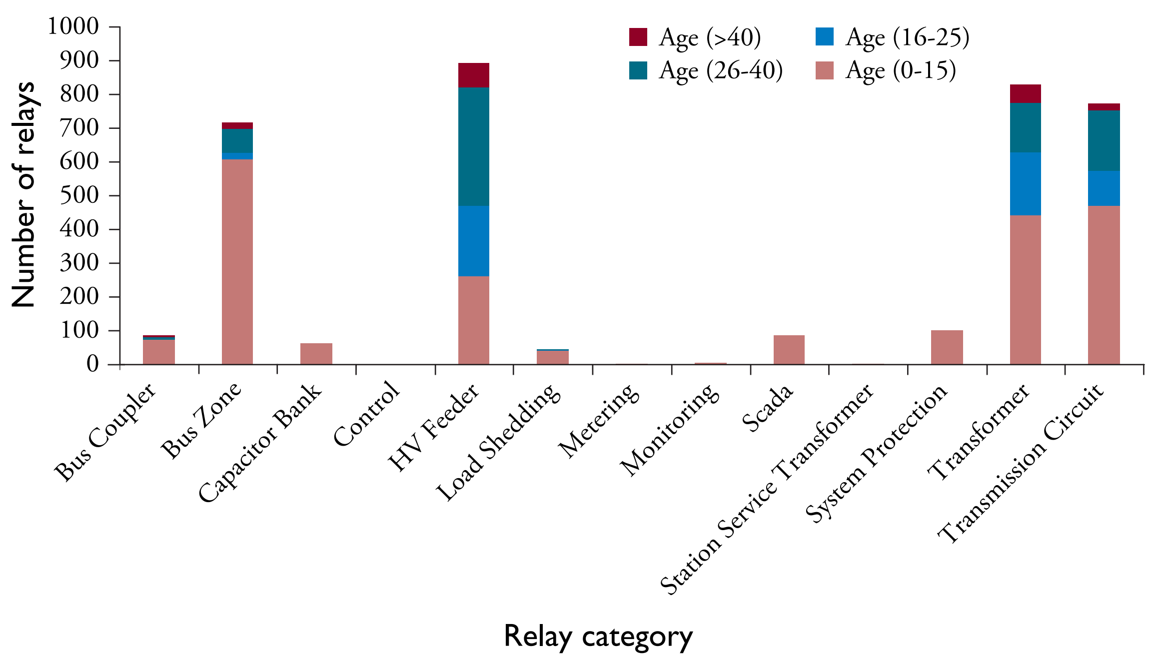


Figure 5.9 - Relay Quantities by Category and Age



5.4.2 Protection and control schemes

Protection schemes must be designed to ensure that the mandated fault clearance times for the various system voltage levels specified in the NER are met. The NER also mandates the need for duplicate protection schemes on transmission lines operating at 110 kV and above. To achieve high-speed clearance over the full length of transmission lines, protection schemes are employed using signalling over telecommunication bearers. Other primary equipment configurations can also require inter-tripping of remote circuit breakers utilising communications circuits.

Issues

Key issues to be addressed in managing Transend's Protection and Control schemes include:

- the replacement of obsolete electromechanical and static protection equipment with microprocessor-based schemes;
- the diverse range of technologies in service;
- the standardisation of scheme designs to achieve most cost-effective solutions;
- strategic upgrades to ensure technical NER system compliance;
- strategic upgrades to allow optimum use of the primary network;
- rigorous management of microprocessor device firmware issues;
- stringent fault analysis to determine system performance;
- HV feeder upgrades to ensure suitable downstream protection co-ordination and functionality;
- better type testing of new technology; and
- better training on new technology.

Strategies

Transend's strategies to manage its Protection and Control schemes include:

- Programs of scheme replacements and refurbishments are ongoing to upgrade schemes that have reached their nominal end of life or to ensure NER compliance. Advantage is taken of opportunities to replace secondary equipment at the same time as other substation redevelopment work.
- New protection schemes have effective remote communications that are used for remote monitoring of parameters and disturbance records.
- New protection schemes also have intelligent relay, self-monitoring and self-diagnostic technology.
- To assess the performance of protection schemes, detailed analysis of operations following faults is undertaken. Advantage is taken of the inbuilt sequence of events and disturbance recorder capability in new digital distance relays. The sequence-of-events capability in substation RTUs is also used to provide comprehensive event recording on a statewide basis for use in analysis of protection operations.
- Protection and control performance is also comprehensively benchmarked against TNSPs and other utilities on an international basis through participation in studies such as ITOMS.
- Routine maintenance and testing of protection schemes will be tailored to the type of scheme and whether or not it has self-monitoring capability.
- Self monitoring protection schemes will be subject to:
  - Functional testing on each modification to the primary equipment or protection circuits.
  - Full routine testing of protection schemes at least every six years.
- Protection schemes without self monitoring capability will be subject to:
  - Functional testing whenever modifications are made to associated primary equipment or protection circuits.
  - Testing for accuracy whenever settings are altered unless such tests have been conducted less than two years from the date of implementation of the changes.
  - Full routine tests on all schemes every three years.
- Control schemes testing will be performed in conjunction with the testing of the associated primary and secondary assets where applicable.

5.5 TRANSMISSION LINES

5.5.1 Overview

This section deals with transmission line assets owned by Transend as well as associated infrastructure such as easements and access tracks which may be owned by others but for which Transend is responsible for maintaining.

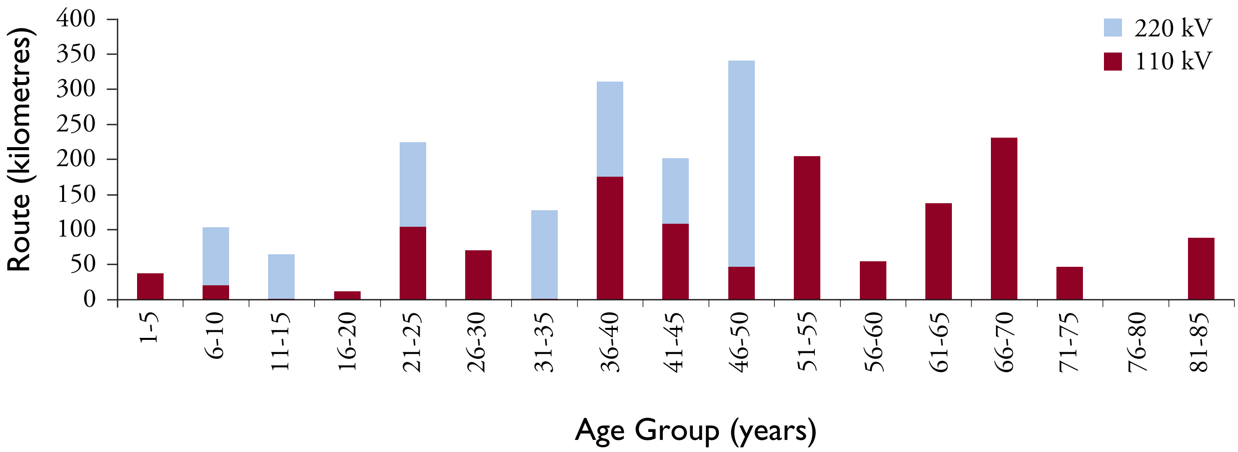
The transmission lines owned by Transend operate at voltages of 220 and 110 kV and comprise a total of 2 358 route kilometres and 3 645 circuit kilometres as detailed in Table 5.2. With the exception of two circuits at 110 kV that comprise underground cable conductor for their entire length, and four circuits at 110 kV with sections of underground cable, all circuits owned by Transend consist of overhead conductor. The transmission lines comprise a number of different support structure types identified in Table 5.3.

Sections of Transend's transmission network are among the oldest in Australia. A total of 69 per cent of Transend's transmission support structures were constructed more than 40 years ago and approximately 28 per cent were constructed more than 60 years ago.

Figure 5.10 shows the age of Transend's transmission line network by route kilometre length.

The age of the transmission line infrastructure influences the required levels of asset and infrastructure maintenance, refurbishment, replacement and enhancement expenditure. The wide diversity of line component types used over such a long period of time also influences the cost and adds complexity to maintenance management.

Figure 5.10 - Age of Transmission Line Network by Length



(Includes underground cables and transmission lines not in service that are maintained for easement retention)

Table 5.2 - Transmission Line Circuit Details

Transmission line type	Route length[1] (km)	Circuit length[2] (km)	Circuits in Service
220 kV aerial	913	1 464	32
Total 220 kV	913	1 464	32
110 kV aerial only	1 401	2 122	64
110 kV underground only	7	7	2
110 kV aerial and underground			45
Aerial component	21	36	--
Underground component	8	8	--
Total 110 kV	1 437	2 173	71
88 kV aerial	8	8	--
Total 88 kV	8	8	--
Total (220 kV, 110 kV and 88 kV)	2 358	3 645	103

[1] Route length (km) is the length in kilometres of a transmission line route. The supports making up the route could be supporting a single circuit or multiple circuits.

[2] Circuit length (km) is the length in kilometres of a transmission circuit. Single or multiple circuits may be supported on the same support. A double circuit line would have two circuit kilometres per route kilometre

The overall asset breakdown structure for transmission line assets, as applied in the formulation of this management plan, is based on the structure adopted by CIGRE[1] . The transmission line assets are split into the following major categories:

- Easements (including vegetation management).
- Conductor assemblies.
- Insulator assemblies.
- Support structures.
- Support structure foundations.
- Electronic and IT tools and management systems.

Detailed management plans have been developed for each of the categories as outlined. The development of the management plans has been based on the outcome of a review of best management practices, followed by the participation of peer groups in various benchmarking exercises. Significant analysis has been undertaken on the risks associated with each individual asset, the issues faced by existing assets and strategies required to address these issues.

5.5.2 Easement Management

A high standard of easement management is critical for ensuring a safe, reliable and secure electricity supply. Easement management comprises the following aspects:

- Vegetation management.
- Easement rights of way management.
- Access management.

Vegetation management is highly critical and is expensive to effectively manage. Easements typically range from 50 to 60 metres wide generally centred about the transmission line route. Transend has approximately 10 500 Ha of easements to be managed.

A vegetation management plan is required as a condition of Transend's transmission licence. This obligation is incorporated in the Easement Management Plan that includes the detailed plans for rights of way and access management. Transend's Easement Management Plan is based on accepted industry vegetation control practices and outlines the management methods, practices and associated processes.

The vegetation management activities including ground inspections, aerial inspections, hand clearing, mechanical clearing and herbicide application to control vegetation regrowth, are discussed in detail in the Easement Management Plan.

5.5.3 Conductor Assemblies

Conductor assemblies include all current carrying phase conductors, overhead earth wires, optical ground wire (OPGW), conductor clamps, spacers, dampers, tension monitors and associated attachments and fittings.

Transend has approximately 11 146 km length of overhead phase conductor. Due to the evolution of the network over a considerable number of years, there is a large variety of conductor types and sizes. ACSR and hard drawn copper conductor make up the majority, being 55 per cent and 32 per cent of the total respectively. Transend has more than 6 000 mid-span compressions, McIntyre sleeves and helical joints in service
on its transmission conductors.

Due to the evolution of the network over a considerable number of years, there is a large variety of earth wire types and sizes in use with the vast majority being ACSR/GZ and galvanised steel earth wire.

Transend currently owns approximately 250 km of optical fibre in the form of OPGW and all dielectric self supporting (ADSS) installed over the transmission network. Apart from new installations, OPGW is being installed where existing earth wires need to be replaced based on condition or fault rating limitations, and where there is no telecommunication system diversity and the need exists.

[1] CIGRE is a permanent non-governmental and non profit-making international association based in France.

Issues

The key asset management issues with conductor assemblies are:

- Substandard conductor to ground clearances on some older lines.
- Some old copper conductor still in service is susceptible to failure.
- Certain transmission circuits are now subjected to increased average load currents and hence face a higher risk of conductor and joint failure due to increased heating.
- Integrity issues exist with respect to conductor terminations, mid-span joints and dead-end assemblies.
- Galvanised steel earth wires close to marine and industrial environments suffer from extensive corrosion.
- Lack of adequate coverage of transmission lines by overhead earthwire.
- Fault rating limitations of some eathwires close to substations.
- Vibration dampers have a nominal life of 25 years. Some populations of Stockbridge, Torsion and Elgra dampers on transmission lines are more than 45 years old and are in poor condition. Some Elgra dampers on 220 kV transmission lines have been found in a failed condition during routine inspections.

Strategies

Transend's strategies to manage its conductor assemblies include:

- Transend is close to completing a program to eliminate substandard conductor-to-ground clearances. Transend continues to address the remaining substandard spans via transmission line reconductoring, replacement and redevelopment/ dismantling projects. Where appropriate, the program has been adapted to fit in with system development programs, thereby reducing overall costs.
- Plans have been formulated to replace old copper conductor either as a one-off program or in association with supply upgrade programs.
- Strategies have been developed to address the overload issues and include infrared inspections and the application of techniques to provide real-time monitoring of conductor temperature.
- Targeted inspections and comprehensive condition monitoring including aerial inspections are undertaken on a regular basis and they include addressing the old copper conductor issues as well as issues associated with conductor terminations, mid-span joints and dead-end assemblies.
- All Elgra type vibration dampers on 220 kV lines are planned for replacement. Stockbridge-type vibration dampers on old copper lines will be replaced as required and based on their condition. Torsio–type vibration dampers, that have been found to be in poor condition, will be replaced.
- Transend has conductor assembly strategies in place to install and maintain aerial markers and bird diverters as required and to undertake condition assessment of all conductors and conductor assemblies during routine transmission line inspections.
- During the 2004-05 financial year, an OPGW rollout strategy was developed. The drivers for this strategy include:
    - Improving the performance of the transmission lines in terms of their tolerance to lightning induced faults.
    - Providing telecommunications network diversity to improve the security of the transmission network.
    - Improving the performance of, and removing capacity constraints in, the statewide corporate data network.

5.5.4 Insulator assemblies

Transend has approximately 45 500 insulators installed on its transmission lines. Glass and porcelain insulator discs are the predominant types, however, more recently the number of synthetic and post insulators have increased. The choice of synthetic and/or post insulators are favoured in some applications due to their increased insulation performance and higher strength-to-weight ratio.

Where historical trends in deterioration are apparent through routine condition assessment, and the need to replace certain insulator types is determined, these will be targeted for replacement. The proposed program of line dismantling will lead to most of the aged insulators being decommissioned during the current planning period.

Identification of deteriorating insulator condition before failure is difficult and programmed detailed inspections are important to monitor the insulation integrity. These inspections are carried out as part of the detailed transmission line inspections.

Testing of the electrical integrity of a statistical sample of porcelain insulators on critical transmission lines is undertaken every five years.

5.5.5 Support structures

Identification of deteriorating support structures before failure is an imperative to avoid high remedial costs and disruption of supply due to transmission line failure. Condition assessment of the support structures is carried out as part of the detailed transmission line inspections.

This assessment includes evaluation for movement, wear, straightness and abnormal tensions or buckling of the structures, and any missing or loose structural members and bolts. Condition assessment is also undertaken of circuit identification labels, danger signs, climbing barriers, climbing barrier gates and locks, and support structure stay wires.

Significant loss of strength can occur to wooden poles because of rot, fungal and/or insect activity that is usually not visible from outside the pole. This degradation is predominantly, but not exclusively, below ground level. Comprehensive pole inspection and testing is undertaken every three years, once a structure reaches 20 years of age.

Table 5.3 - Transmission Line Support Structure Details

Support structure type	Quantity
Lattice	7 912
H-Pole	239
Single Pole	278
Total	8 429

5.5.6 Transmission Line Foundations

Foundations include all structures that are set in the ground, to which the base of the transmission line support structure is attached. Foundations include stay wire anchors and associated earthing systems.

Because of the evolution of the network over a number of years, transmission line foundations vary considerably. They fall within the following categories:

- Directly-embedded steel.
- Concrete-encased steel.
- Rock bolts and wall anchors.
- Directly buried wood pole.

Approximately 98 per cent of foundations comprise galvanised steel directly embedded in the ground. While this foundation type has a lower initial capital cost than the modern concrete-encased pier foundations typically found in other transmission networks, it requires a higher level of ongoing condition assessment and maintenance due to its corrosion susceptibility. Electrolytic corrosion reduces foundation strength due to the loss of galvanising and subsequent pitting of the steel.

Loss of ground cover on foundations adversely affects their integrity as directly embedded foundations rely on the weight of backfill material above the foundation base grillage or tray for uplift strength. Ground cover is sometimes removed by soil erosion, machinery, farming and animal activity.

Rock bolts and wall anchors are sometimes used to terminate conductor spans or provide stay wire anchor points for support structures. Some of these terminations, in areas subject to high levels of moisture, are showing signs of poor condition.

Support structure foundations provide a path to earth for fault currents in the transmission line arising from system faults or lightning. The effectiveness and performance of the transmission line protection schemes, as well as line performance during lightning, relies on foundation earth resistances being maintained to acceptably low levels. Step and touch potential limits for safety of employees, contractors and the public must meet Australian standards, and are influenced by earth resistances in the area of the towers. Foundation earth resistance readings are taken and recorded on a routine basis when significant related capital work is to be undertaken, when a new line is constructed and before commissioning, to confirm telecommunications requirements for earth potential rise (EPR) or as and when required by protection design requirements. Remedial action is taken as required.

Transend has a range of programs for routine condition assessment and monitoring as well as strategies and programs to address specific foundation related issues.

5.5.7 Circuit rating tools and systems

Transend uses a number of electronic and IT systems and tools to facilitate management and operation of its transmission infrastructure, including:

- a transmission line thermal rating program and real time circuit rating program to provide dynamic ratings to Transend's network control operators, and NEMMCO;
- a rating information system to provide 'normal' and 'short time' ratings to Transend's network control operators, and NEMMCO;
- lightning detection system to monitor the type, location and intensity of lightning strikes, used to assist network outage planning, fault location and restoration);
- remote weather monitoring stations for use in determining dynamic circuit rating. Transend uses weather data from 14 Transend-owned stations and four stations owned by other companies; and
- transmission line conductor tension monitors: Transend has 19 conductor tension monitors on 11 transmission circuits.

5.6 TELECOMMUNICATIONS AND SUPERVISORY CONTROL AND DATA ACQUISITION

5.6.1 Telecommunications network and services

Transend requires telecommunications services for certain operational and business applications shown in Table 5.4.

Transend does not own a telecommunications network within Tasmania. It purchases its intrastate telecommunications services from Hydro Tasmania, a small fraction of which is provided via the Telstra network. All interstate services are provided by Telstra.

Transend does own telecommunications assets in the form of communications rooms and associated ancillary equipment within substations and administrative buildings, OPGW and some ADSS on transmission lines and some power line carrier (PLC) equipment. It also owns terminal equipment for interfacing protection, control and data, telephone handsets and mobile radio transceivers.

Some optical fibre and PLC bearers owned by Transend are integrated into the Hydro Tasmania telecommunications network under a commercial agreement.

Hydro Tasmania operates a PABX network and Ericsson Australia operates a Trunked Mobile Radio Network (TMRN). Both of these networks are overlay networks on the Hydro Tasmania digital microwave radio network which provides all inter-nodal trunk circuits and have connections into the Telstra network.

Table 5.4 - Telecommunications Requirements of Transend

Telecommunications service	Category
Transmission System Protection and Asset Protection – includes System Protection Scheme (SPS)	Operational
Transmission Operation and Control System	Operational
Operational Communications	Operational Voice, Business Voice
Corporate Data	Business
Asset Management	Operational
ControlNet	Operational
NemNet	Market
VoiceNet	Operational

The PABX network provides operational and business voice communications services and engineering dial-up services. The TMRN provides operational voice communications services to the electricity supply industry in Tasmania.

In addition to the telephone and mobile radio services, the digital microwave radio network also supports the statewide IP WAN.

At sites where there is neither an existing microwave link nor an optical fibre network connection, Transend uses Telstra services to supplement the Hydro Tasmania network. The management of these Telstra services is undertaken by Hydro Tasmania on Transend's behalf.

The Hydro Tasmania telecommunications' network also supports virtual private network services, where it is necessary to integrate telephone lines supplied by Tasinet (a fully managed telephone service within the Tasmanian Government's Department of Premier and Cabinet) into the Hydro Tasmania four-digit dial plan.

All individual operational telecommunications circuits provided via the Hydro Tasmania telecommunications network are designed for an availability of greater than or equal to 99.95 per cent. In general, all telecommunications services with an analogue interface are designed for an availability of greater than or equal to 99.95 per cent and those with a digital interface are designed for an availability of greater than or equal to 99.99 per cent. As discussed elsewhere, with the exception of those provided via Telstra, all SCADA circuits are duplicated. The combined effect of the duplication is that the telecommunications service to any one RTU has an overall availability that exceeds 99.99 per cent. Where practicable, protection services use duplicated telecommunications circuits. The combined effect of the two duplicated protection systems, which each use a separate telecommunications circuit, also substantially increases the availability of the protection system.

5.6.2 System Protection Scheme

The System Protection Scheme (SPS) is a control system that is required to ensure that the operation of the Basslink interconnector does not degrade the performance of the Tasmanian power system. The SPS relies heavily on the Hydro digital microwave radio network to communicate with nominated load and generation sites. Like the power system SCADA network, the SPS operates in a star configuration, emanating from a hub at two sites. Where there is a critical requirement for SPS, telecommunications circuit route diversity is being provided. Route diversity already exists to most generator sites. Transend assumed responsibility for 44 SPS circuits, eight SPS SCADA circuits and two NCSPS circuits when Basslink was commissioned.

Hydro Tasmania and Basslink Pty Ltd have developed a performance standard in conjunction with Transend to cover the SPS telecommunications system.

5.6.3 Transmission Network Operation and Control System

The transmission Network Operation and Controls System (NOCS) is used for remote monitoring, operation and control of the transmission network from a central control centre. The NOCS is connected to Transend's substations via the telecommunications network. Transend's NOCS is also connected to NEMMCO's monitoring and control system using public network services.

Transend's substations are predominantly equipped with RTUs that interface with the NOCS. Progressively the RTUs are being upgraded to local substation SCADA systems. This upgrade will not impact on the requirements for telecommunications services.

The NOCS is a critical tool for the overall monitoring, operation and control of the transmission system and therefore requires high availability and security. The NOCS is replicated with a Backup Control System (BCS) which is physically located at a different site. The telecommunications network is configured as a 'star network', the hub of which is the NOCS and BCS. Telecommunications circuits are also configured to ensure that RTU communications can be diverted from the NOCS to the BCS in the event of a failure of the NOCS.

5.7 ASSET DISPOSAL

Asset disposal is an intrinsic element in the management of the asset life cycle. Disposal relates to those assets replaced at the end of their service lives or assets which, due to changed circumstances, are no longer required. Disposal strategies for the asset categories are addressed in each of the Asset Management Plans.

Some particular considerations when disposing of assets are:

- Prior to disposal, assets will be reviewed to determine their suitability as system spares in accordance with Transend's System Spares Policy, or for redeployment elsewhere in the transmission system or for offering for sale.
- The disposal of a supply transformer usually leads to a small return to the business from the scrap value which is offset against the cost of decommissioning the unit and transferring it to an appropriate disposal site. Accessories such as bushings or tap-changer parts are also assessed for any recovery value as spares.
- The need to dispose of insulating oils or Sulphur hexafluoride (SF_6) gas in accordance with relevant standards and procedures.

HEALTH AND SAFETY POLICY

Transend Networks owns and operates the electricity transmission system in Tasmania. Our vision is to be a leader in developing and maintaining sustainable networks.

Consistent with our vision, we are committed to providing a healthy and safe work environment for our employees, our contractors and members of the public who may be affected by our business activities.

We will:

- give health and safety precedence in all business activities
- identify hazards and eliminate risk or, if not possible, manage risk to as low as reasonably practicable
- stop or delay activities until effective risk controls are in place
- comply with all relevant health and safety legislation, approved codes of practice and licences, and apply responsible standards where legislation does not exist
- apply a systematic approach to health and safety management to ensure continual improvement
- ensure our employees have the competencies and tools required to safely perform their duties
- require everyone to abide by policies and rules formulated in the interest of health and safety
- set health and safety objectives and targets and monitor our performance and take action to address deficiencies
- consult with and promote active participation of employees in the management of their own and others' health and safety
- foster a culture that encourages employees to act in accordance with this policy
- require that companies providing contract services to Transend manage their health and safety in line with this policy
- include health and safety performance in the appraisal of employees and contractors.

Our health and safety goal is

We all go home without injury or illness

Richard Bevan
Chief Executive Officer
October 2006

Transend Networks Pty Ltd
ABN 57 082 586 892

TRANSEND

ENVIRONMENT POLICY

Transmitting Energy – Efficiently and Reliably

Transend Networks manages transmission lines, substations, switching stations, control centres and offices located throughout Tasmania to efficiently provide a reliable and secure electricity transmission service.

Commitment to the Environment

Transend Networks is committed to excellence in environmental management and undertakes to ensure continual improvement in our environmental performance.

Transend

- complies with all relevant legislation, regulations, codes of practice and other environmental obligations to which the business subscribes
- develops, resources and implements an annual environmental management plan to drive continual improvement in environmental performance
- proactively assesses the environmental risk associated with all activities, and implements measures to manage risk, prevention of pollution and promotion of sustainable development
- manages the risk of potential adverse impacts on the natural environment through diligent asset management and project delivery
- promotes open communications with members of the public, the broader community, and other organisations on the environmental aspects of our business
- monitors and reviews environmental performance to ensure performance objectives and targets are consistently met.

Richard Bevan
Chief Executive Officer
August 2006

Transend Networks P/L
ABN 57 082 586 892

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Station Name	Site Type
Arthurs Lake Substation	Substation
Avoca Substation	Substation
Boyer Substation	Substation
Bridgewater Substation	Substation
Burnie Substation	Substation
Chapel Street Substation	Substation
Creek Road Substation	Substation
Derby Substation	Substation
Derwent Bridge Substation	Substation
Devonport Substation	Substation
Electrona Substation	Substation
Emu Bay Substation	Substation
Farrell Substation	Substation
George Town Substation	Substation
Gordon Substation	Substation
Hadspen Substation	Substation
Huon River Substation	Substation
Kermandie Substation	Substation
Kingston Substation	Substation
Knights Road Substation	Substation
Lindisfarne Substation	Substation
Meadowbank Substation	Substation
Mowbray Substation	Substation
New Norfolk Substation	Substation
Newton Substation	Substation
North Hobart Substation	Substation
Norwood Substation	Substation
Palmerston Substation	Substation
Port Latta Substation	Substation
Que Substation	Substation

Station Name	Site Type
Queenstown Substation	Substation
Railton Substation	Substation
Risdon Substation	Substation
Rokeby Substation	Substation
Rosebery Substation	Substation
Savage River Substation	Substation
Scottsdale Substation	Substation
Sheffield Substation	Substation
Smithton Substation	Substation
Sorell Substation	Substation
St Marys Substation	Substation
Trevallyn Substation	Substation
Triabunna Substation	Substation
Tungatinah Substation	Substation
Ulverstone Substation	Substation
Waddamana Substation	Substation
Wesley Vale Substation	Substation
Butlers Gorge Tee Switching Station	Switching Station
Castle Forbes Bay Tee Switching Station	Switching Station
Hampshire Switching Station	Switching Station
Liapootah Switching Station	Switching Station
Paloona Switching Station	Switching Station
Tarraleah Switching Station	Switching Station
Temco Switching Station	Switching Station
Waratah Tee Switching Station	Switching Station
Wayatinah Tee Switching Station	Switching Station
George Town Transition Station	Transition Station
Rokeby Transition Station	Transition Station

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www.transend.com.au