vector

2003
ASSET MANAGEMENT
PLAN

ASSET MANAGEMENT SUMMARY

This summary is provided to meet the mandatory disclosure requirements of Regulation 25 of the Electricity (Information Disclosure) Regulations 1999, as amended by the Electricity (Information Disclosure) Amendment Regulations 2000.

THE VECTOR NETWORK

The VECTOR network supplies more than one third of New Zealand's electricity peak demand. The distribution business involves the operation and maintenance of a regional supply network that covers greater Auckland and greater Wellington - an area of approximately 5,200km^2. VECTOR has 633,000 customers.

At the time of publication, the Company is also in the process of integrating VECTOR and UnitedNetworks together, bringing with it the best practices from each organisation. For this reason please note that some practices employed in one area of the VECTOR network may not necessarily be employed in another at this point in time.

NETWORK SUMMARY

Area Covered	5,200m^2
Customer Connections	633,000
Supply Points from Transpower	21
Zone Substations	121
Distribution Substations	23,000
Transmission Cables	101km
Subtransmission Cables	597km
Subtransmission Lines	495km
HV Distribution Cables	3,911km
HV Distribution Lines	4,525km

PURPOSE OF THE ASSET MANAGEMENT PLAN

The purpose of the Asset Management Plan (AMP) is to describe how VECTOR will manage the assets and investment in its network in order to achieve the performance targets and strategic goals it has set.

VECTOR's AMP is provided to enable customers and other interested parties to identify VECTOR's performance targets, areas of business focus, forecast levels of maintenance expenditure and capital investment planned to manage its asset base. The plan also identifies our approach to network risk management and contingency planning.

VECTOR's approach to asset management is one which seeks to strike the appropriate balance between the needs and expectations of our customers, and the cost of providing the network service – this incorporates the risk and consequences of asset failure.

VECTOR's asset management approach is to:

- Ensure that the required standard service levels are met
- Provide a safe environment for operating personnel and the general public
- Avoid environmental damage as a result of failing equipment
- Preserve the required functionality, performance and value of assets to enable the continuation of a viable network business

The AMP gives an overview of VECTOR's approach to maintenance, asset renewal, replacement and development. However, please note that this may change once the Commerce Commission finalises its threshold regime. The outcome of this regulatory interface will clarify and define the quality and price path VECTOR takes, influencing our strategy, approach to targeting customer segments and our investment profile.

DATE AND PLANNING PERIOD

The AMP has been developed as part of the Information Disclosure for 2003 and covers a period of ten years from 1 June 2003 until 31 May 2013.

The plan is a view going forward and does not commit VECTOR to any of the individual projects or initiatives set out in the plan. These may be modified to reflect changing operational, regulatory or customer requirements and must be approved through normal internal governance procedures.

The AMP is an evolving document, the review of which is an ongoing process within VECTOR as we gain better information on our customer expectations, asset capabilities and condition.

ASSET MANAGEMENT SYSTEMS AND INFORMATION

Central to VECTOR's goals of providing superior customer service are information systems. Our systems combine the three components of customer management, network management and financial management into one network management strategy.

Decisions on asset performance, asset maintenance, asset replacement, customer responsiveness and optimisation of expenditure require current and accurate information. Enhancing the level of information VECTOR holds on its assets and network, together with implementation of tools to support the effective use of this information continues to be a high area of focus.

In addition to system development, VECTOR has invested heavily in staff training and has staff members involved in international technical working groups such as CIGRE and ESAA to ensure we actively participate in industry initiatives and advancements.

NETWORK AND ASSET DESCRIPTION

VECTOR's network can be viewed as three networks:

1. 110kV transmission network, which connects from the Transpower network to VECTOR bulk supply substations and also provides additional security for the Transpower transmission system.

2. 33kV and 22kV subtransmission network, which connects between the Transpower grid exit points and VECTOR zone substations, each of which serves a particular geographic area with similar asset and customer characteristics.

3. 11kV and 6.6kV, and 400/230V distribution network linking our customers to our zone substations.

Each part of the network is designed, operated and maintained to achieve the levels of reliability set out in this AMP.

SERVICE LEVEL OBJECTIVES

Service for VECTOR is about understanding what our customers value and meeting these requirements cost effectively.

VECTOR has a number of standard service levels against which we assess and measure our performance. The standards give VECTOR a basis for measuring performance and for determining the extent of asset maintenance, repair, refurbishment and acquisition. The standards also assist in establishing more defined customer expectations and therefore customer value. These service standards vary between the network areas reflecting differences in both network design and security standards in addition to customer expectations. As part of our integration process and reflecting the outcomes of the current regulatory environment, we will be looking to identify the potential to align or change these service standards.

Common to all network areas is the continuation of health and safety as an area of focus for the business. VECTOR's policy is to:

> *"Create and maintain a safe and injury free working environment for our employees, our service providers, our suppliers and the public we serve."*

Our safety target for 2003/2004 remains:

> *"No lost time injuries to any person working on our network."*

ASSET DEVELOPMENT AND MAINTENANCE PLANS

Ensuring the network meets the future demands of customer requirements, load growth, statutory requirements, environmental and safety issues, requires VECTOR to continually improve its asset management.

Our approach is to first optimise the use of existing assets where possible through automation, load management or other non-asset development solutions to defer major capital expenditure, so long as our reliability objectives are met and maintained.

Ensuring that asset maintenance, refurbishment and replacement programmes are value-based is also critical to VECTOR. Asset maintenance can be a significant proportion of the total lifecycle costs and VECTOR's approach is one of value-based maintenance to achieve the required reliability standards.

Asset maintenance plans are developed taking into account the variety of customer, environmental, operational performance and condition factors. Generic maintenance plans are developed for each asset type, but are applied based on performance requirements and criticality.

The underlying objective of the asset replacement programme is to identify opportunities where value can be gained through programmes of replacement rather than incurring ongoing remedial and preventative maintenance costs.

To enhance and simplify this process, VECTOR has lifted to another level, the tools and approaches it takes to analysing network information. The objective has been to allow key trends and areas needing focus to be quickly and accurately identified. This information is available to VECTOR and its service providers to assist in the decision making approach.

Our new standards represent the first steps down a new path in network asset management. Our continued focus on improved asset condition and network performance information will improve our decision making process. This in turn will enhance the ability for customers to evaluate their service requirements in terms of cost and performance – enabling a choice to either take their own measures to achieve the performance they require, or contract VECTOR to do so.

RISK ASSESSMENT

Risk is managed in VECTOR by a combination of:

- Reducing the probability of the failure, through the capital and maintenance work programme and enhanced working practices

- Reducing the impact of failure, through contingency and emergency plan development

Management of risk is undertaken by the risk committees, which direct the identification, analysis, prioritisation and treatment of risks across the business.

VECTOR has a suite of contingency plans in place developed under the framework of risk reduction, readiness, response and recovery. Plans are in place to cope with storms, total loss of supply of a zone substation, Transpower grid exit point, the Control Room and Call Centre.

EVALUATION OF PERFORMANCE

Measurement and communication of performance measures is an integral part of VECTOR's management process. Physical performance is tracked through the measures of:

- Reliability
- Safety
- Customer satisfaction

All employees and service providers are accountable for achieving the performance targets. Our service providers are incentivised through a contract bonus structure to achieve their targets whilst VECTOR employees have the performance measures embedded in their performance related pay scheme.

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GLOSSARY OF TERMS

AAC	All Aluminium Conductor
AAAC	All Aluminium Alloy Conductor
ABC	Aerial Bundled Conductor
ABS	Air Break Switch
AMP	Asset Management Plan
ARC	Auckland Regional Council
CAIDI	Customer Average Interruption Duration Index
CBD	Central Business District (of Auckland)
CIGRE	Conference Internationale des Grands Reseaux Electriques (International Council for Large Electric Systems)
CMS	Customer Management System
CSM	Customer Service Monitor
CCT	Covered Conductor Thick
CT	Current Transformer
Cu	Copper
DC	Direct Current
DGA	Dissolved Gas Analysis
DMS	Distribution Management System
DTS	Distributed Temperature Sensing
ESAA	Electricity Supply Association of Australia
FPI	Fault Passage Indicators
GWh	Gigawatt hour
GIS	Geographical Information System
GIS	Gas Insulated Switchgear
GPD	Group Peak Demand
GPS	Global Positioning System
HRC	High Rupturing Capacity fuse
HV	High Voltage
ICP	Installation Control Point
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IED	Intelligent Electronic Data
IPC	Insulation Piercing Connector
km	Kilometre
kV	Kilovolt
kVA	Kilovolt Ampere
kW	Kilowatt
LTI	Lost Time Injuries
LTIFR	Lost Time Injury Frequency Rate
LV	Low Voltage

MEN	Multiple Earthed Neutral
MW	Megawatt
MVA	Mega Volt Ampere
n-1	Security standard
NICAD	Nickel Cadmium battery
Nilstat ITP	Protection relay
ODV	Optimised Deprival Value/Valuation
OSH	Occupational Safety and Health
PILC	Paper Insulated Lead Cable
PVC	Polyvinyl Chloride
RMU	Ring Main Unit
RTU	Remote Terminal Unit
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAP	Systems Applications and Processes
SCADA	Supervisory Control and Data Acquisition system
SF_6	Sulphurhexafluoride
SREI	Safety Rules Electricity Industry
TASA	Tap Changer Activity Signature Analysis
TLS	Transformer Load Simulator
TMS	Transformer Management System
V	Volt
VRLA	Voltage Regulated Lead Acid battery
VT	Voltage Transformer
XPLE	Cross Linked Polyethylene Cable
ZAIDI	Zonal Average Interruption Duration Index

1. INTRODUCTION

1.1. VECTOR ASSET MANAGEMENT OVERVIEW

With more than 633,000 electricity customers in the Auckland and Wellington regions, VECTOR continues to maintain a customer-focused approach to effective asset management. Now, more than ever, customers are demanding greater performance, security and innovation to assist them in growth and development. A key challenge for VECTOR is to continue to understand these needs and push industry boundaries to translate them into solutions that benefit customers and lead the industry forward.

At the time of producing this AMP, the Commerce Commission is in the process of designing its threshold regime for targeted control of lines companies. VECTOR is working constructively with the Commerce Commission to ensure any form of regulation adopted ultimately benefits the customer and does not stifle innovation, inhibit the upgrade of ageing networks or the provision of critical infrastructure for a modern growing economy.

This AMP gives an overview to VECTOR's approach to maintenance, development, asset renewal and replacement. However, please note this may change once the Commerce Commission finalises its threshold regime. The outcome of this regulatory interface will clarify and define the quality and price path VECTOR takes, influencing our strategy, approach to targeting customer segments and our investment profile.

The company is also in the process of integrating VECTOR and UNL together, bringing with it the best practices from each organisation. For this reason, please note that some practices employed in one area of the VECTOR network, may not necessarily be employed in another at this point in time.

There are a number of business strategies such as risk management where the VECTOR and UNL networks are currently aligned. There are, however, a number of other areas such as customer service levels, security design standards, initiatives trialled for reliability etc that are not aligned and reflect differing network characteristics and historical management practices. We will be reviewing these areas to identify the best points from both companies to move towards, taking into account any regulatory impacts.

The objective of the AMP is to describe how VECTOR will manage the assets and investment in its network in order to achieve the performance targets and strategic goals it has set across its networks.

VECTOR is made up of three network areas – Northern, Auckland and Wellington, as shown in Figure 1.1, each of which have differing asset configuration, management and service characteristics. VECTOR's three networks currently operate under two different contractual models. At the time of publication, the Auckland network operates under a conveyance agreement which means it has a direct relationship with each of its 270,000 customers in the Auckland, Manukau and Papakura area. The Northern and Wellington networks are currently run under an interposed agreement which means the company has a direct contracts with retailers, which buy lines services and in turn manage the end-customer relationship.

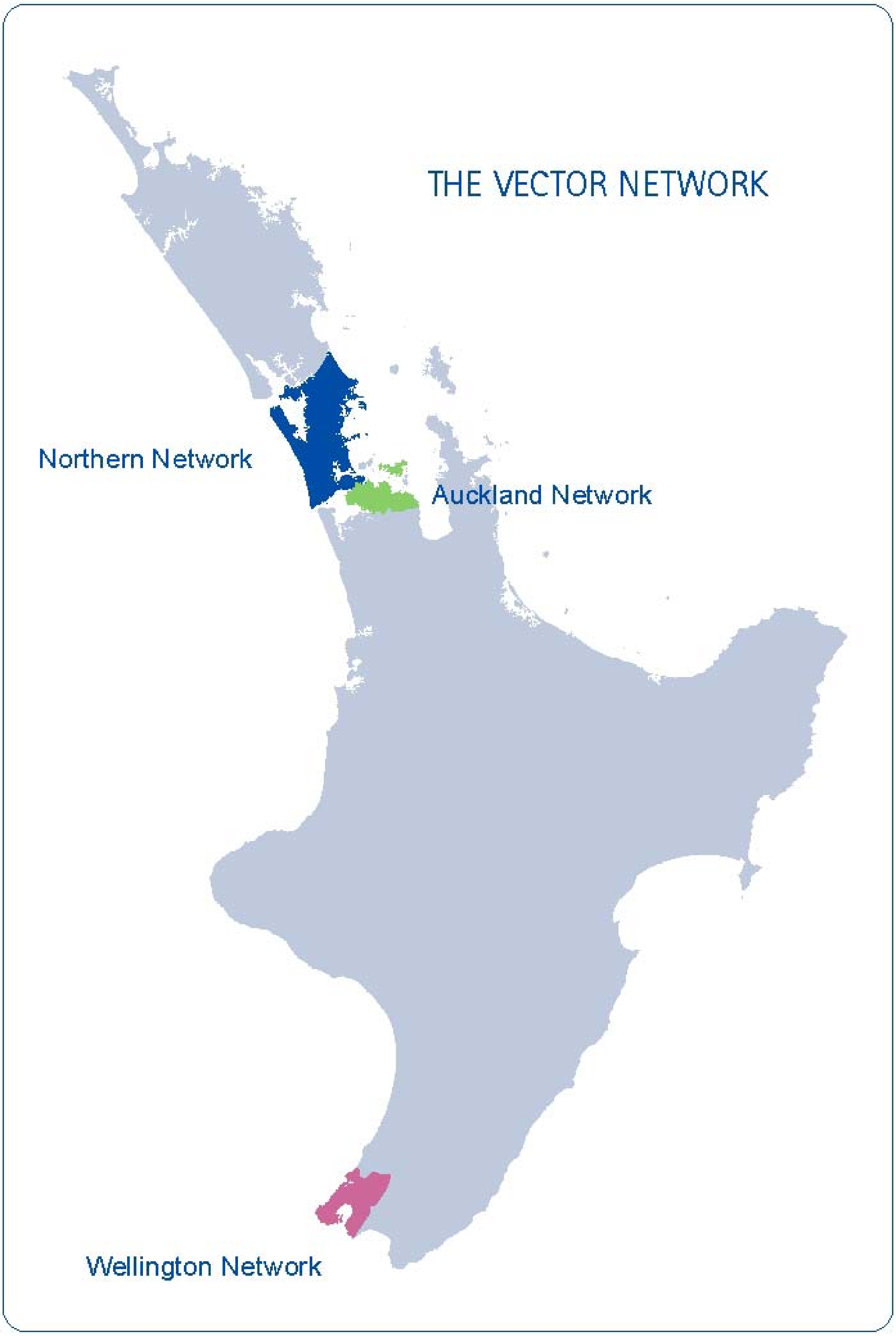

Figure 1.1 The VECTOR Network

The continued focus for asset management at VECTOR is one based on greater utilisation of the existing assets achieved through higher performance. This is achieved through understanding customer drivers, enhanced value-based maintenance strategies, better real-time use of capacity, timely system upgrades and utilisation of advanced condition monitoring techniques and technology. Each investment we make is considered specific to the characteristics of the network areas which the investment serves and, underlying this, what levels of service our customers expect. This requires a sophisticated analysis of technologies, trends in future demands, customer service requirements, asset condition, operational performance and future costs.

To support this objective VECTOR has turned the way information is managed on its head and developed a system that combines the three components of customer management, network management and financial management into one network management strategy. This integrated system provides a common platform for supporting and improving asset management planning, day to day network operations and customer service provision. The system which delivers flexibility, integration of information sources, simplicity and speed for optimal decision making has had huge benefits for network performance, field operations and customer satisfaction, within the Auckland network. The approach will be replicated in the Northern and Wellington networks.

The asset planning process prioritises the programmes for maintenance and development to balance customer service and operational efficiency. Implicit in the asset planning process is an understanding and evaluation of the risks to operation and the consequences of failure. Also critical is the collection of information from which performance can be monitored and improvement targets set.

The AMP is the foundation document for the management of VECTOR's assets. From this document, customers and other interested parties will be able to identify VECTOR's performance targets, areas of business focus, forecast levels of maintenance expenditure and capital investment, and their rationale. The plan also identifies our approach to the management of network risks and our approach to contingency planning.

1.2. NETWORK SUMMARY

The VECTOR network supplies more than one third of New Zealand's electricity peak demand. The distribution business involves the operation and maintenance of a regional supply network that covers greater Auckland and greater Wellington - an area of approximately 5,200km^2. VECTOR has 633,000 customers.

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1.3. ASSET MANAGEMENT PHILOSOPHY

VECTOR's approach is designed to ensure a balance between the needs and expectations of our customers, business objectives, regulatory framework and the cost of maintenance and replacement. This is balanced against the risk and consequences of asset failure.

VECTOR's approach to asset management is to:

- Ensure that the required standard service levels are met, including reliability of supply to customers
- Provide a safe environment for operating personnel and the general public
- Avoid environmental damage as a result of failing equipment
- Preserve the required functionality, performance and value of assets to enable the continuation of a viable network business

Assets must be operated and maintained to continue to meet performance standards cost effectively. Functionality and performance requirements are continually reviewed and revised to reflect the changing operational and customer requirements on the network.

In line with VECTOR's approach to a customer driven level of service provision, the asset management plans are continually developed from analysis of customer requirements, an assessment of the condition of the asset, the risk and consequences of asset failure and analysis of least cost solutions.

The way we develop, operate and maintain our assets is focused to ensure that we are delivering on the standard service levels we have set out in an optimum, cost efficient way. The drivers and performance targets for network development, maintenance and system operation, are developed and linked to ensure the service standards are focused on and achieved, as shown in Figure 1.2.

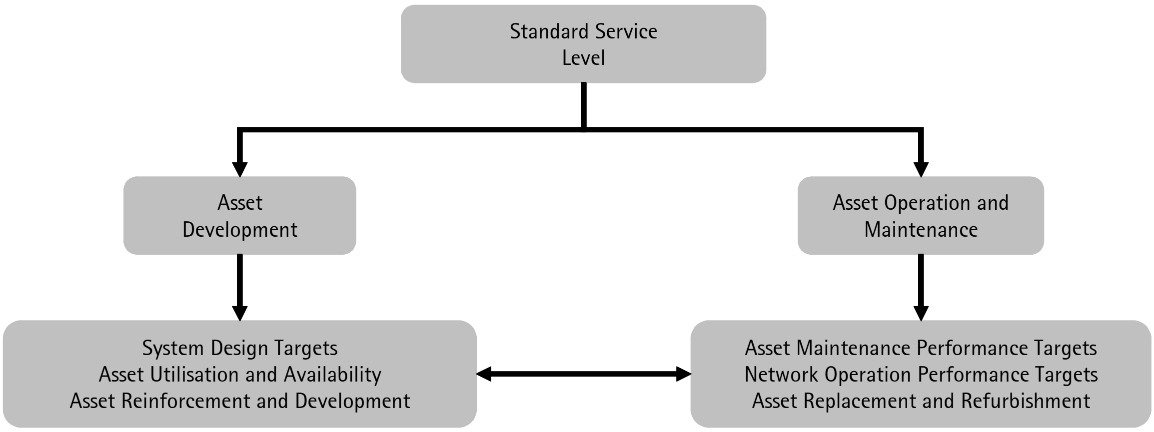


Figure 1.2 Asset Management Philosophy

1.4. ASSET MANAGEMENT PROCESS

VECTOR's Asset Management Process is shown in Figure 1.3.

1.4.1. INFLUENCERS

- ***Shareholders***
  VECTOR is owned by the Auckland Energy Consumer Trust. The Trust is responsible for appointing the Board of Directors and agreeing the Statement of Corporate Intent.

- ***Customers***
  VECTOR manages the network to meet the needs of its customers and works with the energy retailers within the Northern and Wellington networks to manage customer issues.

- ***Regulations***
  Statutory requirements impact on how VECTOR operates to meet its service delivery standards. The following statutes and all subsequent amendments are of particular relevance to this AMP:

The Electricity Act 1992 and Electricity Amendment Act 2001
Electricity Regulations 1997
Electrical Codes of Practice 1993
New Zealand Standard NZS3000 1999
Australian/New Zealand Standard ANZS3000 2000
Health and Safety in Employment Act 1992
Resource Management Act 1991

Other statutes apply to the business as a whole, but are peripheral to the asset management philosophy.

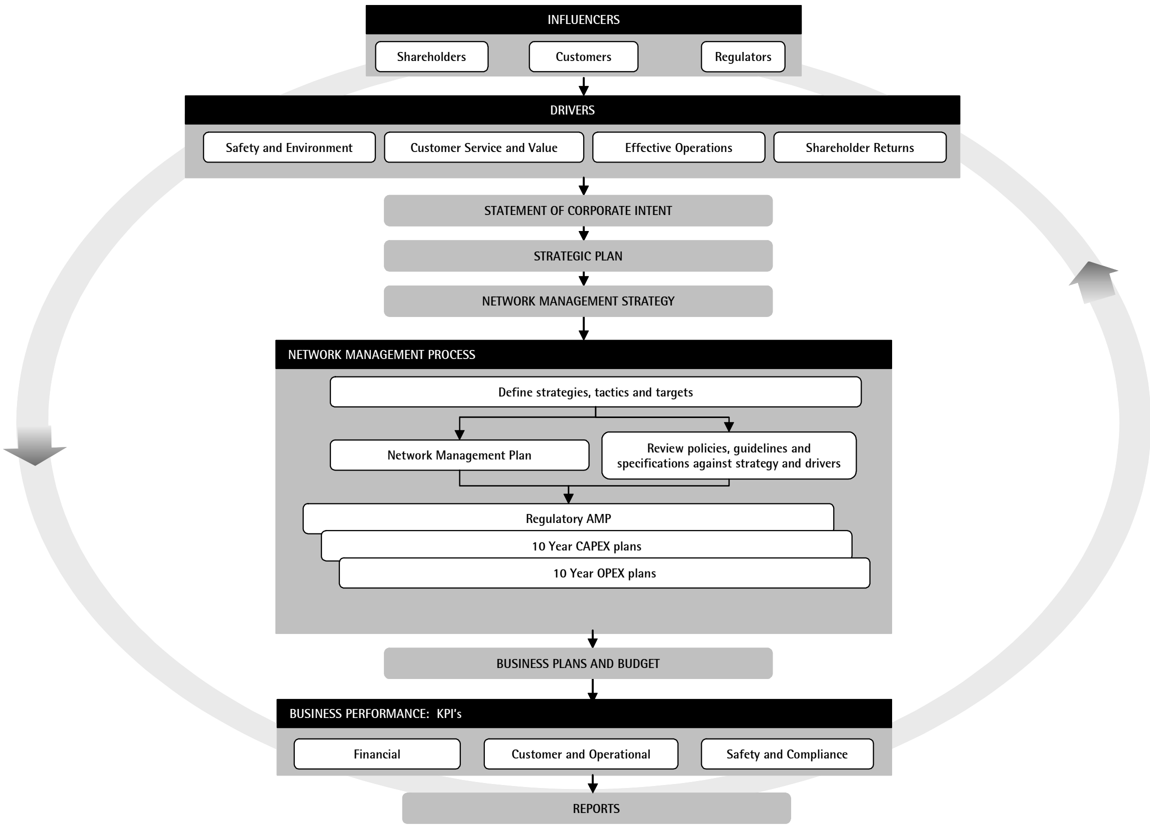


Figure 1.3 VECTOR's Asset Management Process

1.4.2. ASSET MANAGEMENT DRIVERS

- ***Customer Service and Value***
  VECTOR's objective is to deliver improved customer value by matching the performance of both its assets and service providers to the performance its customers expect and are willing to pay for.

- ***Effective Operation***
  VECTOR's objective is to manage the operation of its assets in such a way as to deliver the required performance at the lowest overall cost.

- ***Health and Safety and Environmental Responsibility***
  VECTOR will at all times ensure its employees, service providers and customers safety is not put at risk by the management of its assets. VECTOR will manage the network and act in an environmentally responsible manner and comply with all legal environmental requirements.

- ***Shareholder Returns***
  VECTOR's objective is to manage its assets to meet the shareholders' requirements for return on investment, preservation and enhancement of the value of the company, and community obligations.

1.5. RELATIONSHIP WITH BUSINESS PROCESSES

The AMP is directly influenced by a number of other policy documents and processes:

- ***Statement of Corporate Intent***
  This document defines the Directors' intentions and objectives for VECTOR for the financial year and is agreed with the shareholders. This encompasses planned business activities and objectives, values, and performance targets.

- ***Strategic and Business Plans***
  The five year plan, annual plans and key initiatives are established to support the achievement of performance targets.

- ***Network Management Strategy***
  This defines the approach and direction for network management in terms of network value, performance, revenue and customer expectations for service and quality.

- ***Performance Targets***
  Performance targets are established for the company as part of the long-term and annual planning rounds. These include customer service, network performance and financial targets. These are cascaded down to individual business units and service providers.

1.5.1. PLAN IMPLEMENTATION

The outputs from the asset planning process, which incorporates continual review of asset functionality requirements and customer feedback, are the operational, maintenance and capital work programmes.

- ***Asset Maintenance Plans/Schedules***
  For each customer area, asset or asset group, specific maintenance programmes are established annually, taking into account long-term strategic positioning.

- ***Asset Development***
  For each customer area, capital works programmes are developed to ensure service delivery.

- ***Equipment and Design Standards***
  Equipment and design specifications, based on the required functionality of the assets, are included in the Network Standards Manuals, policies and guidelines. These documents are continually reviewed to ensure the standards are based on current performance and functionality requirements, and to take advantage of new working practices and technology, to ensure minimum asset lifecycle costs.

1.6. PLANNING PERIOD

This AMP covers a period of ten years from 1 June 2003 until 31 May 2013. The plan is a view going forward. It does not commit VECTOR to any of the individual projects or initiatives set out in the plan. These may be modified to reflect changing operational, regulatory or customer requirements and must be approved through normal internal governance procedures.

The AMP is an evolving document, the review of which is an ongoing process within VECTOR. VECTOR encourages and welcomes stakeholder comment on the plan. It is likely that the AMP will evolve significantly over the next year as part of the integration of the VECTOR and UNL networks.

1.7. RESPONSIBILITIES AND ACCOUNTABILITIES FOR ASSET MANAGEMENT

The responsibilities for asset management are outlined in Figure 1.4.

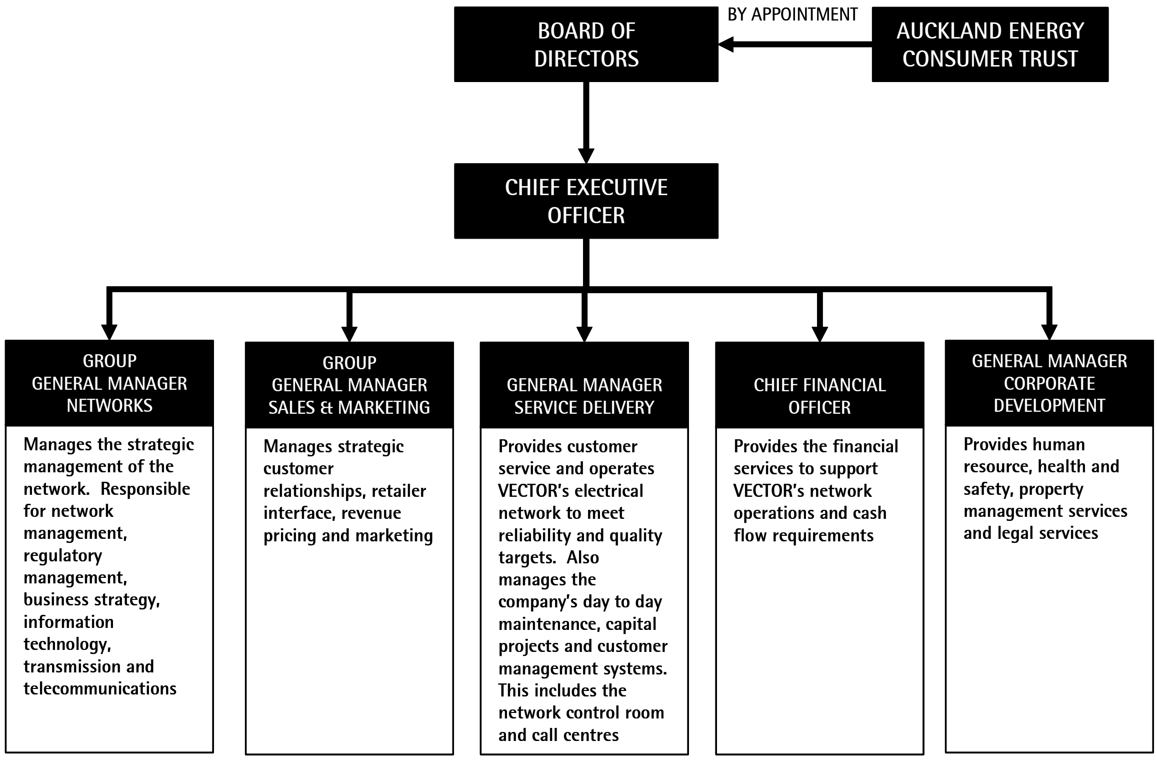


Figure 1.4 Asset Management Structure Chart

1.8. ASSET MANAGEMENT INFORMATION SYSTEMS

1.8.1. OVERVIEW

Decisions on asset performance, asset maintenance, asset replacement, customer responsiveness and optimisation of expenditure require current and accurate information. Enhancing the level of information VECTOR holds on its assets and network, together with implementation of tools to support the effective use of this information continues to be a high area of focus.

The integration with UNL over the coming months will standardise, where practicable, the systems and approaches to information collection and analysis across the company. The following information primarily relates to the systems and approaches that exist for the Auckland network.

The GIS remains the central focus for asset information collected within VECTOR and information flows between the GIS and other corporate systems. Our service providers are accountable for the provision of accurate, timely asset maintenance and fault data into the GIS, and are contractually incentivised to do so.

Collection and validation of asset information using field computers is a key feature of VECTOR's information system strategy.

1.8.2. GIS SYSTEM

The GIS system is the cornerstone of VECTOR's asset management information systems. The system is used for the following business applications:

- Performance monitoring for customer management
- Analysis of asset performance
- Data for calculation of the network ODV
- Exported data files for import into network analysis applications
- Geographic based analysis of customer data
- Asset preventative maintenance and test recording
- Base data for asset maintenance scheduling
- Reference for asset location
- Network model for import into SCADA/DMS

The following developments to the system have been completed over the past 12 months.

Extension of the System to Support Requirements for SCADA/DMS

The GIS system provides the foundation data for the SCADA/DMS system. To allow this the accuracy, range and type of data recorded in the GIS has been expanded significantly over the past 12 months

A key area has been the establishment of an integrated schematic view of the HV and Subtransmission network.

Analysis Tools

VECTOR has lifted to another level, the tools and approaches it takes to analysing network information. The objective has been to allow key trends and areas needing focus to be quickly and accurately identified. This information is available to VECTOR and its service providers to assist in the decision making approach.

Examples of the types of output are shown below.

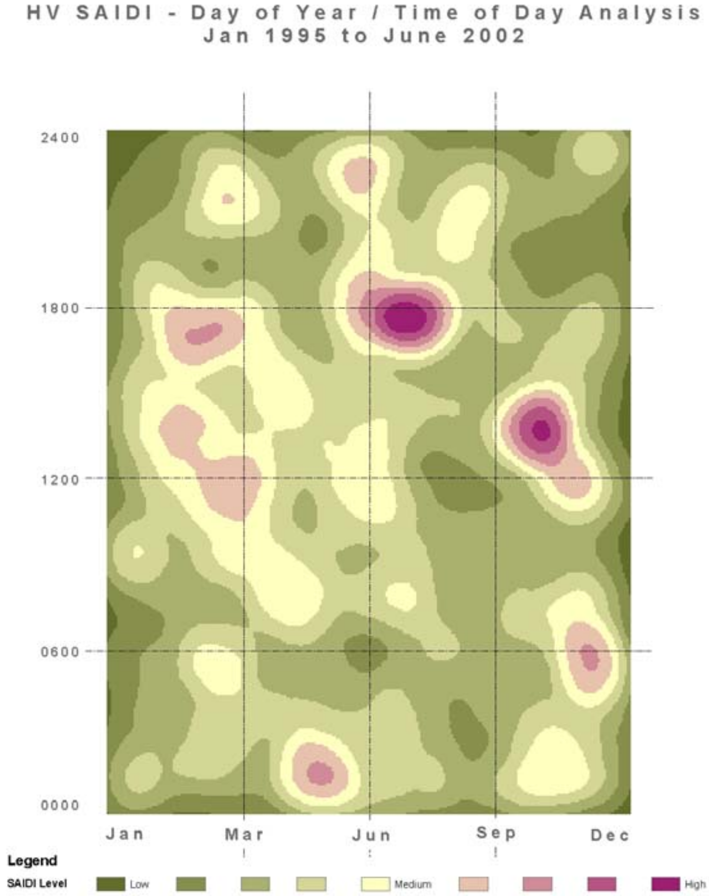


Figure 1.5 HV SAIDI Analysis Tool

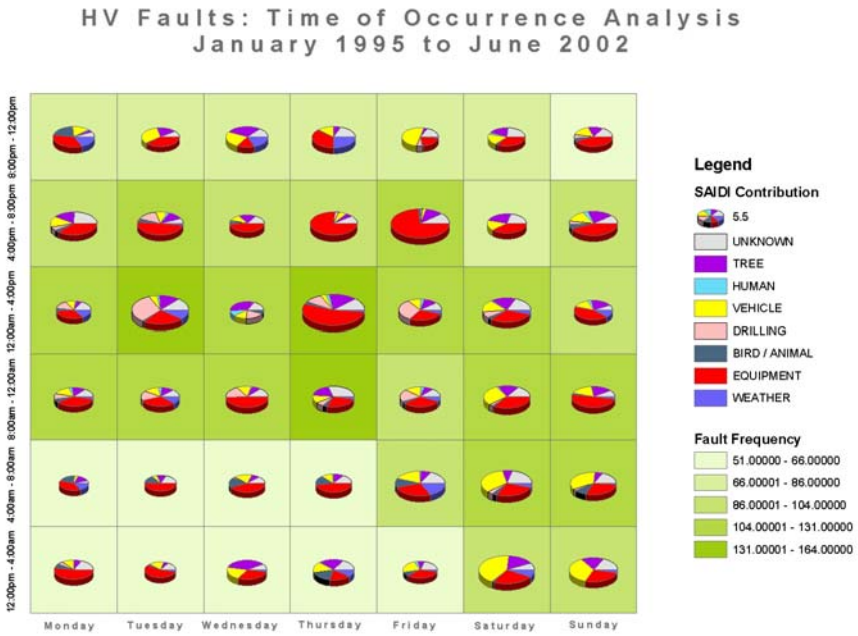


Figure 1.6 HV Fault Analysis Tool

Network Analysis Integration

The establishment of a network schematic view in the GIS provided opportunity to develop a method for creating data files (both graphics and attribute data) for direct use by VECTOR's network modelling software. This integration provides major reductions to the effort involved in undertaking electrical analysis projects.

Field Data Collection and Verification

A GIS based field application has been developed and implemented to allow recording of inspections, tests and defects as part of VECTOR's preventative maintenance programmes.

In addition the system also allows errors in the GIS data, noticed during field inspections, to be corrected in the field, thereby efficiently improving data quality.

1.8.3. SCADA/DMS (SUPERVISORY CONTROL AND DATA ACQUISITION/DISTRIBUTION MANAGEMENT SYSTEM)

The project to implement a new "real-time" network management system has continued this year.

Following comprehensive evaluation of systems available, a solution from *Telegyr Systems* (SCADA), *CES International* (DMS) and *Siemens NZ* was selected, as our SCADA/DMS system.

The solution provides base SCADA functionality, integrated with advanced distribution management system (DMS) functions including outage management, switching management, real-time load flow analysis and dynamic asset rating.

The system is integrated, both with VECTOR's GIS system (for network data) and with its Customer Management System (for customer call taking and for provision of information on outages to customers).

When operational, the system will provide VECTOR with advanced tools, that will improve customer service (through more accurate and up to date information on faults), reduce restoration times, improve asset utilisation and reduce the potential for human error.

System implementation commenced in September 2001, and will be "livened" in phases between June 2003 and August 2003.

1.8.4. AUXILIARY NETWORK ANALYSIS TOOLS

DIgSILENT Powerfactory

VECTOR use a specialised software package, DIgSILENT Powerfactory, for all power system related modelling and analysis within the Auckland network.

The complete subtransmission and high voltage distribution network is modelled, from the Transpower Grid Exit Points to the low voltage terminals of VECTOR's distribution transformers.

This network model is being used for load flow, short circuit, network reliability, protection device coordination, motor starting, network loss assessment, open point optimisation and power quality analysis. It is also used for developing VECTOR's reliability based network planning approach.

This approach will be extended into the Northern and Wellington networks.

CYMCAP

CYMCAP continues to be used for calculation of ratings for underground cables.

1.8.5. THE NEXT 12 MONTHS

The following are the principal planned developments of VECTOR's network information systems:

- Establishment of common systems for the VECTOR and UNL networks, including alignment of the GIS
- Further development and application of information analysis tools
- Selection and refinement of field information tools

2. NETWORK ASSETS

2.1. NETWORK OVERVIEW

The overall architecture of the network is shown in Figure 2.1.

The network can be considered as three networks – transmission, subtransmission and distribution. The 110kV transmission network connects the Transpower network to the VECTOR bulk supply substations for VECTOR supply, but also supports security on the Transpower transmission system north of the VECTOR supply area. The high voltage subtransmission network also connects the Transpower network at the grid exit points to zone substations, at 33kV or 22kV. Each substation serves a particular geographic area, with known asset and customer characteristics. At the substations the voltages are further stepped down to 11kV or 6.6kV. The distribution network then carries the electricity to distribution transformers, or for some commercial customers, directly to their premises. At the distribution transformers electricity is stepped down to 400/230V, for final delivery to customers.

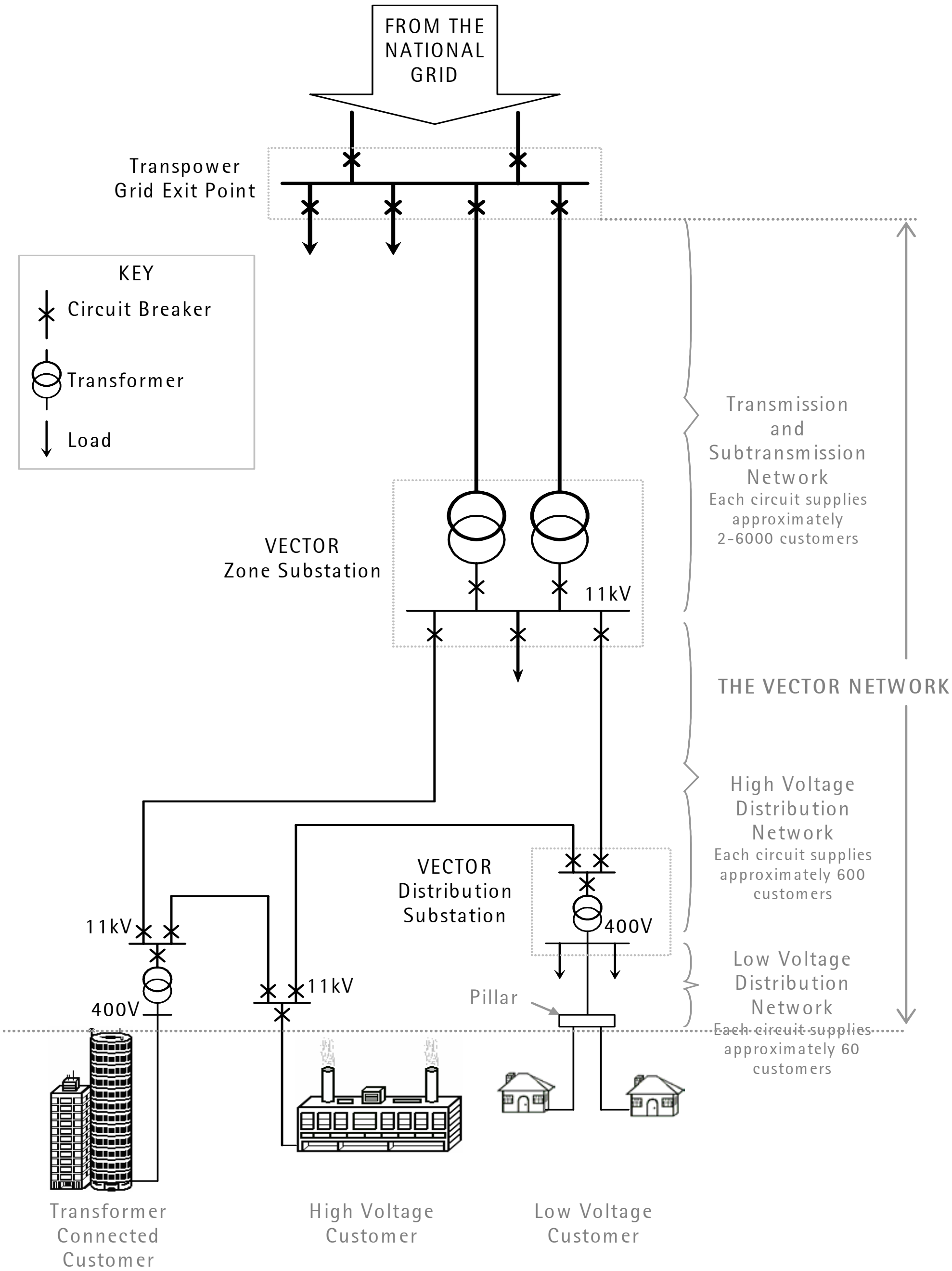


Figure 2.1 Schematic of VECTOR's Network

2.2. TRANSMISSION AND SUBTRANSMISSION NETWORK

The higher voltage transmission and subtransmission network is designed to transfer large amounts of electricity efficiently, and also provides additional security to the Transpower cross-isthmus network. The network transfers electricity from Transpower's network via 21 grid exit points, to 121 zone substations. A zone substation typically supplies between 2,000 to 6,000 customers. The subtransmission network consists of a combination of overhead lines and underground cables

At the zone substations, the subtransmission voltages are stepped down to 11kV (or 6.6kV) to supply the distribution network. The zone substations are all remotely controlled via the SCADA system, which allows remote operation to be carried out from the Control Room and returns load and equipment operation information.

2.3. TRANSMISSION AND SUBTRANSMISSION DESIGN

The transmission network has been developed essentially as a radial network. The subtransmission networks in Auckland and Wellington have been designed as radial feeders, with two or three transformers at each zone substation. There are no ties between zone substations at subtransmission level (other than in the CBD).

The subtransmission network in the Northern region is a combination of radial feeders and mesh networks. The future development of the subtransmission system will be driven by the reliability and design standards and customer service levels, and may include single transformer stations, and more interconnections at subtransmission voltage.

Auckland Network

Generally the load on a zone substation should not exceed 30MVA in the Auckland network, in order to keep the number and size of 11kV feeders within practical bounds. In some cases where the load is relatively concentrated, the design maximum load can rise to 50MVA (eg, in the CBD, where land for new zone substations is expensive and difficult to obtain, or in heavily industrial areas).

If there is to be no loss of supply for a single subtransmission circuit fault, the allowable load on the station is limited to the sum of the short-term ratings of the remaining healthy circuits. VECTOR's new design philosophy permits the station load to be increased beyond this limit by accepting a small probability that in the event of a fault, load will have to be shed immediately while load transfers are carried out, with the proviso that all supply is restored within three hours. For the subtransmission security targets see Section 3.

Wellington Network

In the case of Wellington, each zone substation was designed to an n-1 security standard. Because of the closed ring formation of the 11kV distribution network, the amount of interconnection between different zones is very limited. The size of transformers in Wellington varies between 10MVA to 30MVA depending on the load density of the area the zone substation supplies. The design for zone substations in the Hutt and Porirua areas are similar to that for Wellington, that is, to maintain a single contingency security. The radial (interconnected) nature of the distribution network however provides additional backup supply under multiple contingency situations. It should also be noted that due to fault level issues, the transformers at 12 of the Wellington network zone substations cannot be operated in parallel.

Northern Network

The subtransmission network in the Northern Region is configured in a mesh formation. Security of the network is dependent on the power flow in the network under different contingency conditions. The transformers at six of the Northern network substations cannot be operated in parallel.

2.4. DISTRIBUTION NETWORK

The function of the distribution network is to deliver electricity from the zone substations to customers. It includes a system of cables and overhead lines operating mainly at 11kV, with some 6.6kV, which distribute electricity from the zone substations to distribution substations. Typically 600 customers are supplied at the high voltage distribution level. At the distribution substations the electricity is then stepped down to 400V and delivered to customers either directly, or through a reticulation network of overhead lines and cables. Approximately 60 to 500 customers are supplied from each distribution substation, via the low voltage distribution network. For larger loads, electricity can also be delivered at 6.6kV, 11kV or (for very large loads) 33kV. Four main categories of customer connection are available and the final network connection type is determined through consultation with the customer. The connection types are:

- Single phase low voltage
- Three phase low voltage
- Transformer connection
- High voltage connection

A number of customers are fed by dedicated substations, and take supply at 33kV or 11kV.

2.5. DISTRIBUTION DESIGN

The distribution system in Auckland, Northern and the Hutt areas consists of interconnected radial circuits originating from zone substations. The design is based on the concept of availability of feeder backstopping capacity, according to the security standards. A distribution feeder fault may result in an outage, but in urban substations supply should largely be able to be restored within two to three hours by switching operations on the distribution network. This system provides a very reliable means of electricity supply. In the case of Wellington, the backbone 11kV network is constructed in the form of closed rings fitted with unit protection. In this type of network, no supply loss will be experienced by customers under single contingency situations. From the backbone closed ring networks, radial feeders have also been developed to supply the marginal demand. These radial feeders are interconnected to allow backup under emergency conditions.

The distribution circuits are controlled by automatic circuit breakers at the zone substations. Oil switches and air break switches are installed at strategic locations on the circuits to provide operational flexibility. A key focus is on automation of these switches in the network where applicable to improve service levels. For the distribution security targets see Section 3.

There are a number of large customers in the Auckland network connected to the network at high voltage. The ownership of the substations serving these customers varies from site to site, but generally VECTOR owns the incoming switchgear and any protection equipment associated with it. The customer usually owns the transformer(s), any outgoing switchgear and associated protection, and the building. Similar arrangements exist in the Wellington and Northern areas. All customers in Wellington CBD are supplied at low voltage.

2.6. PROTECTION

VECTOR's network is protected from the Transpower grid exit points to the customers supply point by protection relays and fuses.

The main role of protection relays is to detect network faults by monitoring various parameters (current, voltage, etc) and to initiate opening of relevant circuit breakers should an abnormal situation be observed. This minimises damage to the equipment, hazards to people and loss of supply to customers.

All new and refurbished substations are equipped with multifunctional Intelligent Electronic Devices (IED's). Each IED combines protection, control, metering and monitoring functions within a single hardware platform communicating with the substation computers over an optical fibre LAN using industry standard protocols.

2.7. COMMUNICATION NETWORK

VECTOR's inter substation communication networks consist of optical fibres and copper wire telephone type pilot cables and UHF/VHF radio. Radio is used to provide communication to field installed devices.

The operational communications network consists of different architectures and technologies. VECTOR is progressively migrating its operational services to an Ethernet and IP technology based communication network.

2.8. METERING

VECTOR's bulk metering system consists of a number of intelligent web-enabled revenue class energy and power quality meters of type ION7600 and ION7500. The meters communicate to the metering central software over an Ethernet based IP routed communication network.

A number of the meters installed at zone substations are of ION7700 type. These meters communicate to the central computer over the GSM communication network. The system provides VECTOR with essential information to control the cost, quality and reliability of the power delivered to VECTOR's customers, and is currently used to:

- Improve operational efficiency by controlling peak demands at the bulk supply points, which ultimately reflects in reduced line charges to VECTOR's customers;
- Provide comprehensive power quality and reliability information that will enable the verification of the quality of power delivered to our customers against the published VECTOR Service Levels, and faster resolutions of power quality issues;
- Increase the power system stability by initiating instantaneous load shedding during under-frequency events.

2.9. LOAD CONTROL SYSTEM

VECTOR's load control system consists of a number of audio frequency (475Hz and 1050Hz) ripple control plants, pilot wire and DC Bias systems, as well as a small number of CylcoControl plants. These assets together with our metering system give us the ability to:

- Control of residential hot water cylinders (load shedding)
- Street lighting control
- Meter switching for tariff control

2.10. IMPROVEMENTS TO NETWORK DESIGN

The current network architecture is continuously reviewed to ensure an architecture that is structured around meeting the customers needs while achieving technical excellence (the customers needs are reflected by VECTOR's service level standards and feedback from customers) at an economically sustainable level.

The approach is to develop an optimised network architecture based on customer needs, cost, reliability and network losses. Network simulation software is one tool that will be used to select the optimum solution. Performance parameters will be established to measure the success of any project and we will continuously strive to improve our performance through feedback and optimisation.

Technological developments and innovation in areas such as distribution network automation (eg, remote switching, intelligent metering) and distributed generation technology will be considered in the process.

Data (eg, fault, customer, power quality and load data) collected by Network Development, Service Delivery and Commercial will be used for analysis, to determine trends and to perform investigations with the ultimate goal of identifying areas for improvement.

In addition to technical performance the network architecture will address issues such as amenity value and health and safety requirements.

3. SERVICE STANDARDS

Service for VECTOR is about understanding what our customers value and then meeting these requirements cost effectively where appropriate. It encompasses providing our customers with a safe, reliable supply of electricity, providing customer specific solutions, being accessible to customers, and providing accurate timely information.

Our customer research has shown that different groups have different needs and tolerances of power fluctuations in terms of length and time of day. All research indicates that reliability in terms of fault frequency and duration of outages is important to customers, but with different levels of criticality.

For a number of commercial and industrial customers, feedback has indicated that power quality is, in many cases, as critical as outages. Power quality is the provision of supply within acceptable parameters such as voltage, frequency and waveform distortion. In the VECTOR networks we have a number of customers sensitive to voltage fluctuations, many of whom run continuous process operations with high costs associated with a disturbance or loss of supply. Customer requirements and willingness to pay for varying service levels will ultimately drive performance.

VECTOR has maintained a number of standard service levels against which we assess and measure our performance. The standards give VECTOR a basis for measuring performance and for determining the extent of asset maintenance, repair, refurbishment and acquisition. The standards also assist in establishing more defined customer expectations and therefore customer value. These service standards vary between the network areas reflecting differences in both network design and security standards in addition to customer expectations. As part of our integration process and reflecting the outcomes of the current regulatory environment, we will be looking to identify the potential to align or change these service standards.

Network performance at VECTOR is managed at three levels:

1. Reliability targets set at network level in the Northern and Wellington networks and in the Auckland network for individual zones to align with our standard service levels by customer type, SAIFI and CAIDI (which in turn, give SAIDI)

2. The ability to handle extreme contingencies with the minimum impact to the customer, through risk mitigation. This is managed through our formal risk management process as in the "loss of substation" and similar scenarios.

3. Power quality and customer responsiveness.

3.1. RELIABILITY

Reliability reflects what the customer sees, as it is a measure of how often the power is off and for how long. Reliability is primarily a function of the original design and specification, equipment selection, maintenance practices and the operating regime. Reliability is generally measured by the industry standard measures of SAIDI, SAIFI and CAIDI.

$$\text{SAIDI} = \frac{\text{Sum of (Number of Interrupted Customers x Interruption Duration)}}{\text{Total Number of Connected Customers}}$$

$$\text{SAIFI} = \frac{\text{Sum of (Number of Interrupted Customers)}}{\text{Total Number of Connected Customers}}$$

$$\text{CAIDI} = \frac{\text{Sum of (Number of Interrupted Customers x Interruption Duration)}}{\text{Sum of (Number of Interrupted Customers)}}$$

The measures of SAIDI, SAIFI and CAIDI are used as they provide a consistent measure of performance across the network that can be compared on a year by year basis. VECTOR's reliability performance targets are disclosed in accordance with the Electricity (Information Disclosure) Regulations 1999 and as amended by the Electricity (Information Disclosure) Amendment Regulations 2000. The following figures show actual progress on SAIDI, SAIFI and CAIDI for the Auckland network up to 2001 with time weighted results for 2002 for the combined Northern, Auckland and Wellington networks. The time weighted combined results and targets for 2002 and targets for 2003 are shown in Table 3.1.

Measure	2002 Target	2002 Actual	2003 Target
SAIDI	56.1	87.4	69.9
SAIFI	1.0	1.4	1.2
CAIDI	53.7	62.9	58.3

Table 3.1 Time Weighted Combined Results for SAIDI, SAIFI, CAIDI

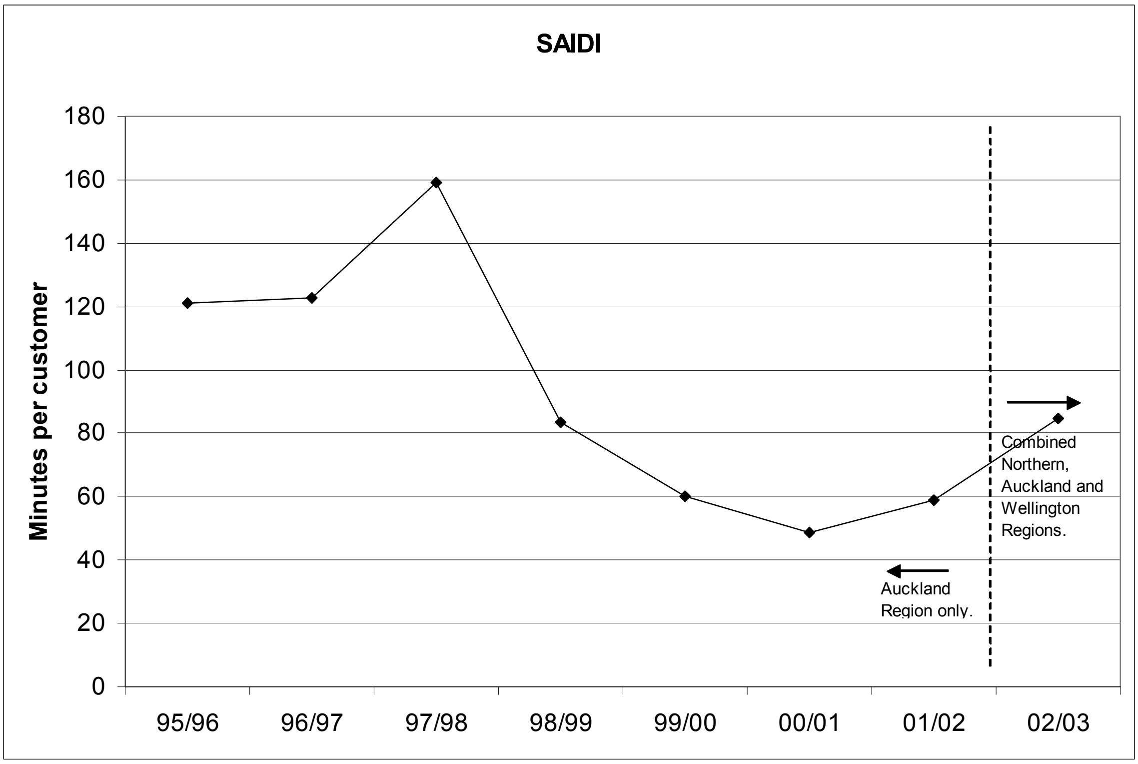


Figure 3.1 SAIDI Actuals (including Transpower outages)

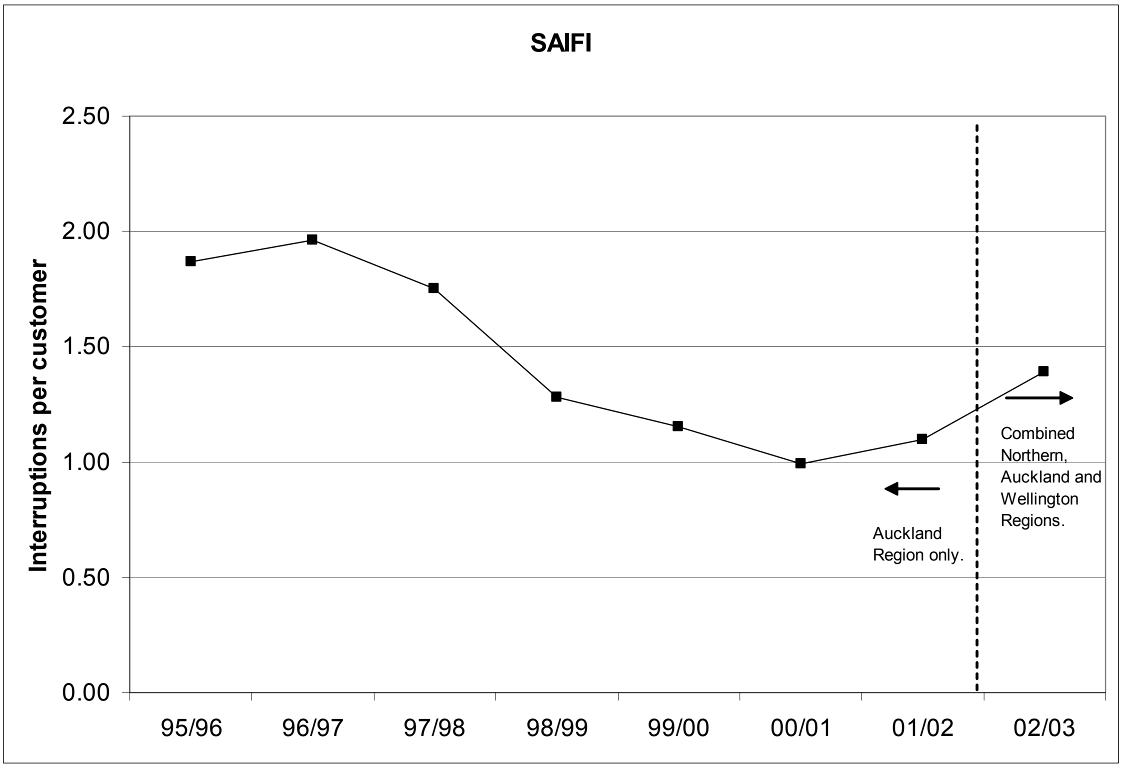


Figure 3.2 SAIFI Actuals (including Transpower outages)

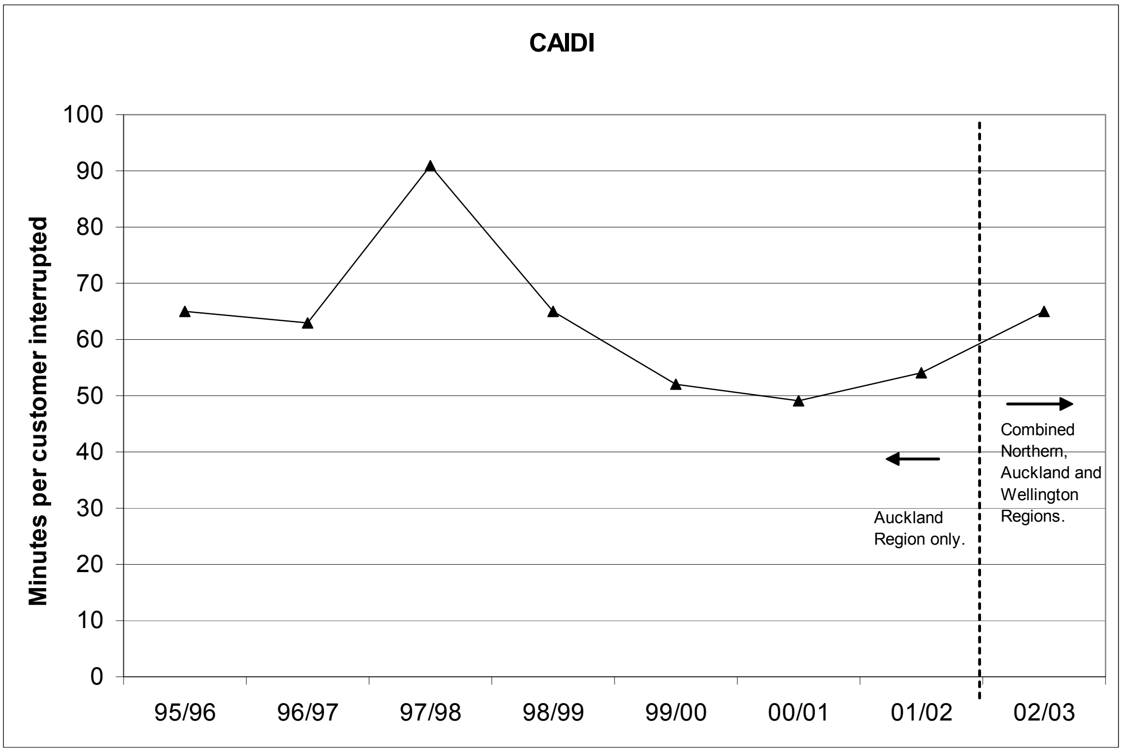


Figure 3.3 CAIDI Actuals (including Transpower outages)

Although we are not yet reaching the key reliability targets we have set for our networks, we are seeing the benefits of targeted asset management practices.

Whilst weather has had a significant impact, there are a number of areas we will focus attention on in the coming year to improve this position. These include planned maintenance practices in the Northern and Wellington network areas and vegetation management practices in all network areas.

Our focus last year on reducing the human error component of the reliability results has had very good results. Initiatives included working with our service providers to improve switching practices – we will continue to maintain focus on this area.

3.2. NETWORK MANAGEMENT

Auckland Network

Within the Auckland network, the risk of an outage occurring for customers in a given area is calculated and assessed against the baseline level of service for that customer type. This ensures that effort is directed to proactively highlight poorly performing areas and specific corrective actions taken to enhance reliability.

To align the reliability targets with our customers' requirements and expectations which vary across the network, we have implemented specific outcome targets for different zones. These standard service levels, shown in Table 3.2, give our customers a reasonable expectation of what level of service they will receive from VECTOR, dependant upon what region they live in. Customers will be able to contract for higher levels of reliability and quality where required.

		Reliability		Quality
Customer Group	Service Area	Potential Number of Faults Per Year	Maximum Restoration Time Per Fault (hours)	Potential Number of Events Per Year Where Voltage Sags to Less Than 80% of Nominal Value
Large Commercial	Commercial	Up to 3	Up to 2	Up to 20
	Industrial	" 4	" 2	" 20
	Residential	" 4	" 2.5	" 30
	Rural	" 14	" 3	" 40
Small Commercial	Central*	Up to 4	Up to 2.5	Up to 30
	Rural	" 14	" 3	" 40
Residential	Central*	Up to 4	Up to 2.5	
	Rural	" 14	" 3	

**For customer groups by zone substation, central relates to everything but rural*

Table 3.2 Standard Service Levels: Reliability and Power Quality

For network management purposes, within the Auckland network, reliability targets and standard service levels are translated into SAIDI, SAIFI and CAIDI targets for our service providers.

The SAIFI fault frequency targets are reviewed to understand if there is a particular asset or group of assets causing high fault frequencies, or a particular fault cause in an area. The results of the analysis can then be used to initiate revised preventative maintenance, asset refurbishment or replacement programmes, or other solutions if the fault cause is external, such as car versus pole or directional drilling.

The CAIDI fault duration targets are reviewed to understand what is causing the high duration outages and what the potential solutions could be. The solutions could range from restructuring of the fault crew response, automation, or installation of fault passage indicators, to assist efficient fault location.

We have developed sophisticated analysis techniques to enhance our understanding of fault patterns, based on time of day, area, and assets to enable focus to be placed in areas which are causing problems.

Service providers are incentivised under the performance nature of the contract to manage the operation and maintenance of the network to achieve the network reliability targets and customer service standards. The annual maintenance plans are developed as a result of the review and analysis of SAIFI and CAIDI performance, and the optimum management plan to achieve the standard service level for that network is established.

Northern and Wellington Networks

The standard service levels for our customers in the Northern and Wellington networks are shown in Table 3.3. These standard service levels give our customers a reasonable expectation of what level of service they will receive from VECTOR, dependant upon what type of area they live in.

Customer Group	Average Fault Restoration Time (hrs)
Urban	3
Rural	6

Table 3.3 Standard Service Levels: Northern and Wellington Networks

In the Northern and Wellington networks, the reliability targets for service providers are currently at network level and the service providers are incentivised under the performance nature of the contract to manage the operation and maintenance of the network to achieve the reliability targets. It is our intention to replicate the approach used in the Auckland network, but first we have to collect and analyse the data available for those networks to understand their performance and capabilities to enable us to set appropriate reliability targets.

3.3. SYSTEM DESIGN SECURITY

We are currently in the process of integrating VECTOR and UNL together and will be reviewing the system design security criteria with a view to development of common criteria based on the strategic long-term vision of the business. In the interim, VECTOR will continue to manage the assets of the networks based on the existing criteria.

3.3.1. AUCKLAND NETWORK SECURITY

VECTOR's approach to asset management and network planning has historically been driven by the following principles:

- Customer needs, which vary by market segment and are reflected by service level standards, are trending towards higher reliability and improved power quality.
- Take customer needs, currently, into consideration

- Capacity and network reinforcements are investments and VECTOR strives for least cost solutions (optimum asset utilisation) and the deferring of capital expenditure
- Investment strategies and service offerings provide improved value to customers and improved return to shareholders
- Risks management strategies are aligned with the planning philosophy
- Continuously strive for innovation and optimisation in network design and introducing leading edge technology like sophisticated scheduling and remote switching technology to improve utilisation

In support of these principles, VECTOR moved away from a deterministic planning approach to a probabilistic approach, which recognises that our product has variable reliability and quality and that the customer's needs and business strategy should drive investment in the network.

Reliability based planning is the foundation of this approach. It is a probabilistic evaluation of the networks ability to meet customer needs. It assesses the probability of failing to supply customers load by applying long-term industry averages cross checked with actual VECTOR statistics for failure rates and repair times for all network elements (cables, lines and transformers) in a stochastic model. The outputs of the model are then used to assess the reliability of the network and to compare the relative reliability of different options.

The success of reliability based planning depends on the data and the model used. This means overlaying the industry long-term averages with VECTOR data.

The short-term goals are to apply this model for:

- Comparing the network reliability with customer specified reliability requirements and costs
- Overlaying recorded service level standards indices with predicted values and identify areas to focus on to get the maximum improvement
- Refining service level standards to determine service levels that are consistent with the network
- Improving asset utilisation and determine the optimum capital expenditure and network reinforcement window
- Demonstrating the relative improvement in reliability for different planning options

The long-term goals include requirements such as including the impact of ageing assets and the total cost of reliability.

The ability to predict the reliability of the network with confidence, combined with alternative technical solutions, advances in information management, communication and distributed generation are providing the framework within which planning can meet customer expectations while improving the return to shareholders.

The reliability implied by the current service level standards will apply until the output of the reliability based planning modelling provides more customer and network specific service levels.

3.3.2. AUCKLAND NETWORK TRANSMISSION, SUBTRANSMISSION AND DISTRIBUTION RELIABILITY

Type of Zone Substation Load	Acceptable Probability of Loss of Supply in a Year Due to Subtransmission Events
CBD or predominantly industrial	0.5%
Mixed commercial/industrial and residential	2%
Predominantly residential	5%

Table 3.4 Transmission and Subtransmission Security

No customer will be without supply for longer than three hours following any single subtransmission fault.

Type of Feeder Load	Acceptable Probability of Loss of Supply in a Year Due to a Backstopping Shortfall
CBD or predominantly industrial	0%
Mixed commercial/industrial and residential	2%
Predominantly residential	5%
Overhead spur up to 1MVA	100% (no backstop)
Underground spur up to 300kVA	100% (no backstop)

Table 3.5 Distribution Security

No customer will be without supply for longer than three hours following any single feeder fault (except for customers on spurs, where in some circumstances the repair time may exceed three hours).

The variation between areas is for two reasons:

1. The reliability requirements of CBD, industrial and commercial customers are higher than residential.

2. The load profiles in different areas vary; residential areas have peaks of typically less than three hours, so an outage which leads to an inability to supply all customers in a peak time is basically self-correcting, but commercial and industrial areas have much longer peaks.

This approach will lead to more consistent levels of reliability and security across the network.

3.3.3. NORTHERN AND WELLINGTON NETWORK SECURITY

The historical approach adopted for the Northern and Wellington Regions applies deterministic criteria as an initial screening process on security, to identify areas where more detailed analysis is required, using probabilistic methods.

3.3.4. NORTHERN AND WELLINGTON TRANSMISSION, SUBTRANSMISSION AND DISTRIBUTION RELIABILITY

		Minimum Demand to be Met	
Group Peak Demand (GPD) MVA	Type of Substation Load	1st (Tx/cct) Outage	2nd (Tx/cct) Outage
Up to 1.0	Overhead spurs (LV or HV) Lightly loaded feeders	100% GPD in repair time, target 3 hrs urban, 6 hrs rural	Repair time (refer definitions)
Up to 0.8	Underground spurs (LV or HV) Lightly loaded feeders	100% GPD in repair time, target 3 hrs urban, 6 hrs rural	Repair time (refer definitions)
Up to 12	Urban feeders Urban zone substations	100% GPD within 3 hrs	100% GPD in repair time
Up to 12	Rural feeders Rural zone substations Rural grid connection points	50% GPD within 6 hrs, 100% GPD in repair time	
12-60	Urban zone substations	100% GPD immediately	50% GPD within 3 hrs, 100% within repair time
12-40	Remote grid connection points Rural zone substations	75% GPD within 6 hrs, remaining load in repair time	100% GPD in repair time
60-200	Zone substations supplying high density load areas	100% GPD immediately	100% GPD within 2 hrs
40-300	Normal grid connection points	100% immediately	50% GPD within 3 hrs, 100% within repair time

Table 3.6 Security of Supply Criteria

A Network Security Model has been developed to identify the various conditions and areas where loss of a network component could result in loss of supply to consumers. Fault statistics based on long-term industry averages are used to identify the probability of equipment failure. Based on the expected demand and the capacity of back up supplies, the model calculates the demand not met due to the loss of a network component. Using this information, together with load duration characteristics and the average time required to restore supply, an estimate of the energy not served due to the fault is assessed. In this way, the model analyses costs of non supply due to failure of network components such as transformers, busbars and subtransmission circuits and compares them with the cost to remove the risks. This provides guidelines regarding reinforcement expenditures.

The security standards for the three regions of VECTOR are based on the historical standards that existed prior to the merger with UnitedNetworks. This will be reviewed and may have to change to reflect the overall asset management strategy of the new company.

3.3.5. ALL NETWORK AREAS

For all network areas the reliability and security standards represent the first steps down a new path in network asset management. With a true customer focus, we will establish baseline or customer-specified reliability standards for each feeder. This will drive capital investment decisions, maintenance and fault repair practices, long-term spares holding policy and emergency response plans. Our continued focus on improved asset condition and network performance information will improve the decision making process. We will be able to provide customers with reliability options and associated costs, allowing them to choose whether they will take their own measures to achieve the reliability they want, or contract VECTOR to do so.

3.4. POWER QUALITY

VECTOR recognises the importance of power quality to our customers.

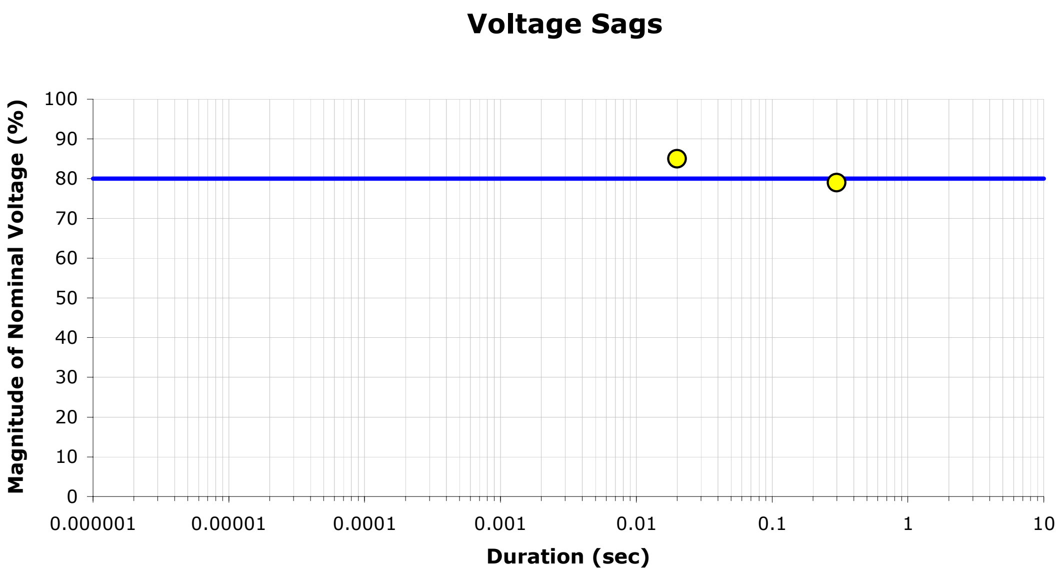
The VECTOR networks are designed to a quality level that most modern equipment can effectively operate with. However, as technology advances, new electronic equipment is becoming increasingly sensitive to power disturbances. Also, some specific businesses, such as those in manufacturing and service industries, have a higher reliance on disturbance free power.

VECTOR continually strives to reduce power disturbances that affect our customers. However, all electricity networks are subject to unplanned disturbances and it is impossible to guarantee a perfect power supply free of voltage sags, surges or harmonic distortions. A sag is a momentary decrease in voltage below the normal tolerance, typically lasting less than some milli-seconds. They are often the result of faults or incidents occurring elsewhere, including disturbances originating from neighbouring commercial premises or even your own equipment, the effect of which ripples through parts of our network.

The following strategies have been implemented to effectively report and manage the impact of power quality on customers and VECTOR's network.

- An ongoing programme to install power quality measuring equipment at grid exit points, zone substations and customer sites
- An electronic mail system that automatically sends a power quality report in real time to customers informing them that their plant could have experienced a power quality disturbance

- A web based reporting system that makes both real time and historical power quality information available to customers. Figure 3.4 illustrates a typical report that is available on the intranet for customers to access
- The application of modelling software and tools to predict the impact of power quality disturbance on customers
- The application of mobile power quality instruments to investigate power quality related complaints



Voltage Sag Summary for Takanini Zone Substation			
From 11 February 2003		To 12 May 2003	
1 Phase Sags	2 Phase Sags	3 Phase Sags	Interruptions
2	0	0	0

Figure 3.4 Voltage Sags

4. NETWORK DEVELOPMENT

The network must efficiently meet the future needs in terms of customer requirements, load growth, statutory requirements, environmental and safety issues. As part of the strategic planning process, it is critical to ensure that any investment is cost effective over the planning period and phased in at the optimum time. Risks, costs and benefits are reviewed and revised as new load growth and asset capacity, utilisation and capability information becomes available.

Our approach is to first optimise the use of existing assets where possible through automation, load management or other non-asset development solutions, and thereby defer major capital expenditure, provided that our reliability objectives are not compromised. Capital expenditure is mainly driven by growth and new connections but compliance with regulations and safety issues and replacement of aging assets, contribute significantly to the capital spend.

This section gives an overview of the major development projects planned for the network. These plans may change following the finalisation of the threshold regime by the Commerce Commission and VECTOR's subsequent clarification and definition of quality and price path.

4.1. FORECAST GROWTH

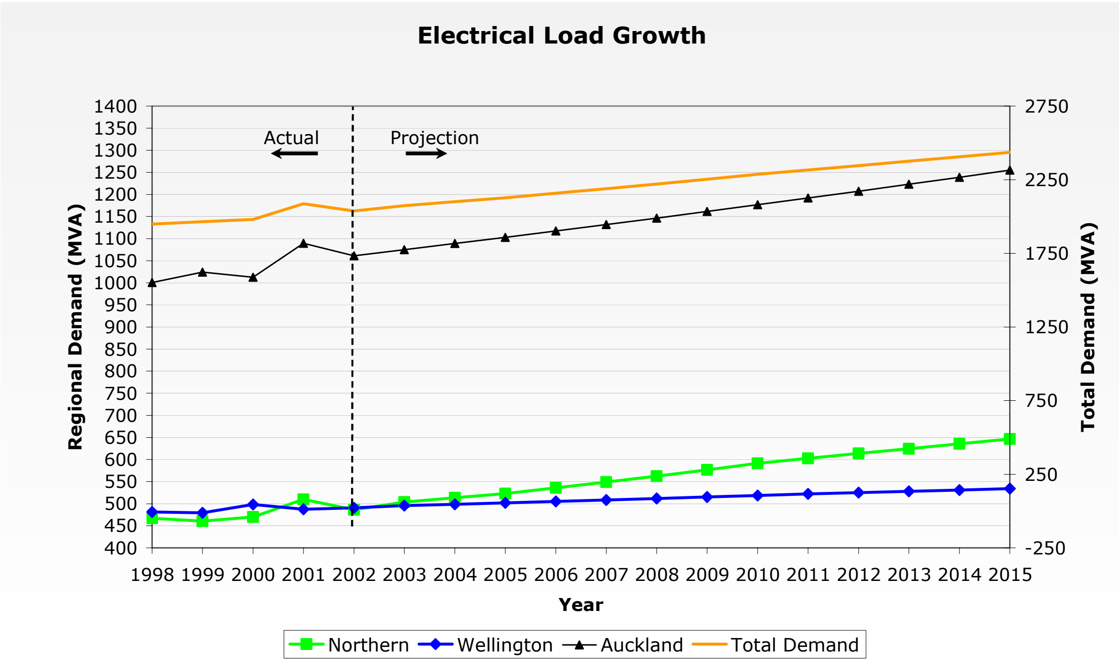


Figure 4.1 Forecast Maximum Demand across the Network

The long-term forecast for VECTOR's total network shows an average growth rate of 1.4% per annum. Figure 4.1 shows the forecast demand growth across the network. VECTOR forecasts peak demand at a zonal level based on data from the SCADA system at zone substations and 11/6.6kV feeders. The forecast is for a "normal" climate year, therefore the actual demand is adjusted for any climate extremes experienced. Peak demand is then forecast for the next 15 years. An underlying basic growth factor specific to the particular zone substation is applied, reflecting the expected impact of economic growth, population growth, available land for development, District Plan changes etc. Individual commercial developments are accounted for where known. The forecasts are then adjusted to include block load transfers between zone substations, which are planned as a capital expenditure deferral strategy, but also deliver improved asset utilisation as well.

Short-term maximum demand in VECTOR's network is mainly influenced by climate, particularly the severity of winter. Medium term demand is mainly driven by population growth with specific area growth being governed and regulated by regional council development and district plans, and also area specific commercial developments.

The load on VECTOR's network is primarily an urban load, consisting of:

- Residential load
- Small commercial loads, such as dairies and single shops or small blocks of shops
- Large commercial loads, including shopping malls and light industrial factories
- Large industrial loads, ranging from large factories to steel mills

Peak demands do not occur simultaneously. Advantage is taken of the diversity of load profiles when designing the network. Residential loads tend to peak in the evening, with a peak lasting two to three hours from 17:00 hours. Commercial loads tend to peak during the day with a peak lasting five or six hours. Peak demands are seasonal and area specific, with some areas peaking in winter and others in summer. The underlying trend for peak demands is moving towards a summer peak, particularly in commercial areas, and the network will have to be designed and operated to ensure performance is maintained under changing customer usage patterns.

The challenge for VECTOR is to manage the maturing network at an economic level. Reinforcement and development projects are reviewed and planned for when the forecast loads exceed the system design security criteria outlined in Section 3.

4.2. NETWORK INVESTMENT

VECTOR invests in its network for three reasons:

1. To provide additional capacity for growth.
2. To replace assets which have come to the end of their economic lives.
3. To maintain and improve where necessary the service provided by the network.

VECTOR's approach to network investment is to seek the best value investments. This is done by considering a wide range of traditional and non-traditional solutions for each investment.

Most alternative solutions, such as automation and load management, provide incremental increases in capacity from existing assets at a fraction of the cost of traditional, capital intensive solutions. These solutions are an efficient way of deferring traditional investment and reduce the risk of large traditional investments being stranded, especially in low load growth areas.

VECTOR has a process of evaluating and, where appropriate, implementing alternatives to traditional investment in network assets. Each investment is considered specific to the characteristics of the network area in which the investment serves. This requires a sophisticated analysis of technologies, trends in future demands, customer service requirements and associated costs.

VECTOR is working together with the University of Auckland to increase expertise in such sophisticated analysis techniques. A research project continues to develop a model for optimised investment decisions. The model takes into account the impact of all alternative solutions on network capacity and customer service levels. Optimisation techniques are then employed to find which solutions will satisfy future capacity requirements and service level criteria at a minimum investment cost.

4.2.1. NETWORK CONSTRAINT MANAGEMENT

As load grows throughout the network the capacity of existing assets will be soaked up. Eventually constraints will emerge where the load on the existing assets is such that VECTOR's service levels are compromised. Prior to this point VECTOR looks to invest to relieve the constraint.

Constraints are local to the specific area served by the constrained assets. Constraints are also time dependent – they occur only when existing capacity is exhausted and are relieved as soon as further capacity is provided through investment. Constraints can occur at any point in the network, in the transmission network, the subtransmission network or the distribution network. Generally, the lower down the network the smaller the area of customers affected and the smaller the level of investment to relieve the constraint.

Investment to relieve constraints is carried out in the same manner as other VECTOR network investments. A range of alternative solutions is considered. To ensure that as wide a range of solutions as possible is considered, VECTOR looks to signal constraints to potential solution providers.

A particularly cost-effective means of relieving constraints is via load management. Constraints can be relieved by:

- Reconfiguring the network to reduce the load in the constrained area, and
- Encouraging customers to shed load at peak times, and
- Local generation

In addition to the major proposed projects outlined in the AMP, VECTOR makes a number of smaller, but sizeable, investments throughout its network each year. VECTOR is investigating other ways of signalling the need for these investments to encourage third party solutions eg, embedded generation.

4.2.2. NON-TRADITIONAL INVESTMENT SOLUTIONS

Non-traditional investment solutions fall into the following areas:

Increasing the utilisation of existing assets

- Improved control of network assets (remote controlled and automated switches)
- Real-time monitoring and rating of assets
- Targeted maintenance programs

Demand-side response

- Embedded generation (both new generation and use of existing generation – eg, CBD building emergency generators)
- Customer load management – real-time access to sheddable loads in peaks

- Customer demand reduction – through price signals, demand reduction programmes – run by VECTOR or third parties
- Energy storage devices
- Demand exchange – evolving market mechanism developed to enable load to be traded

Customer investment
- Investment in site equipment (power factor correction, voltage conditioners etc)
- Insurance to cover risks
- Determining specific service levels

New technologies are emerging in all of the above areas.

4.2.3. DISTRIBUTED GENERATION

Distributed generation refers to energy production embedded within the distribution network. It includes production from power plants, customer back up generators and smaller generation technologies such as solar panels and fuel cells.

VECTOR has two physically embedded power plants at Greenmount (5MW) and Waste Management (2MW) in the Auckland network and one notionally embedded power plant at Southdown (120MW). There are physically embedded power plants at Redvale (2MW) and Rosedale (2MW) in the Northern network and at Silverstream (1MW) in the Wellington network. A number of customers also generate power from their own solar panels. The technical requirements for generator connection to the VECTOR distribution network are specified in a public document.

VECTOR employs distributed generation as a non-traditional investment solution that is considered and applied where appropriate. A current initiative is to identify and pursue agreements with customers with back up diesel generators for load management during peak load times on the VECTOR network.

VECTOR is a co-sponsor of the Centre for Advanced Engineering study "A New Zealand Study on Distributed Generation". The study is evaluating the impact of distributed generation on transmission and distribution networks in New Zealand.

4.2.4. THIRD PARTY SERVICE PROVISION

VECTOR recognises that third parties can provide some of the above investment solutions. VECTOR encourages third party service provision through the communication of:

- The required outcome the solution must provide
- The area the solution is required in
- The timeframe in which the solution is required

VECTOR's policy is to compensate third parties for the provision of services, including distributed generation, so long as:

- The risk of the non-provision of the service can be managed so that it does not breech VECTOR's service standards
- The provision of the service complies with VECTOR's technical codes and does not interfere with other VECTOR customers
- Payments to service providers are linked directly to the provision of the service
- Commercial agreements are reached on connection, including use of network costs

Compensation is based upon the actual benefit received by VECTOR. To ensure VECTOR receives the maximum value from these investments it seeks to:

- Encourage the number of possible solutions and participants, and
- Set prices through competitive process
- Ensure timeframes are short (to enable other solutions to emerge over time)

4.3. ASSET DEVELOPMENT

A number of localised areas within the VECTOR network have been identified as approaching the point where VECTOR's supply reliability criteria cannot be maintained. Each issue and constraint is reviewed to determine the optimum operational and economic approach to addressing the problem and maintaining customer service by considering the following options:

- Increased asset utilisation, through advanced automation, dynamic ratings etc
- Load management (including demand side management)
- Level of acceptable risk
- Asset performance improvement
- Customer requirements and customer based solutions
- Capital investment

This results in a revised asset development programme in terms of the:

- Solution adopted to address the issue or constraint
- Timing of the solution
- Cost of the solution

It is expected that by improving the utilisation of assets, VECTOR will be able to stage investments and defer or reduce overall capital expenditure. Detailed investigation of the options will occur before any new project is committed. Significant projects are summarised in this section, with their approximate cost range (ie, < $1million, between $1 and $3 million, and > $3 million). "Committed" status indicates that the project has an approved budget.

4.4. AUCKLAND CUSTOMER AREA

4.4.1. GROWTH IN THE AUCKLAND AREA

This area covers Auckland City, Manukau City and parts of Papakura District.

Demand growth is not consistent throughout the Auckland area, with some areas experiencing rapid growth due to new developments and others experiencing low or negative levels of growth as areas become fully developed or existing commerce and industry move away.

Residential demand is expected to increase in central Auckland with the development of new apartments and refurbishment of offices into apartments, which will continue at a high rate for the next few years. Residential growth in the Manukau City and Takanini/Alfriston areas are also high because of a high number of planned subdivisions. Residential growth elsewhere in the Auckland network is expected to be low, with infill housing being the major form of development.

Industrial and commercial development is expected to continue to be focused in the Avondale area and around East Tamaki, with large retail development in Mt Wellington. Industrial and commercial load growth is also expected to continue in the Wiri and Manukau areas, and in the vicinity of Auckland airport.

4.4.2. ISSUES AND OPTIONS IN THE AUCKLAND AREA

A1: Onehunga/Te Papapa Area

Project	*Onehunga substation uprating to 33kV*	
Driver	*Growth*	
Timescale	*Within 5 years*	
Status	*Subject to load growth and condition monitoring*	*Estimated capital >$3 million*

The Onehunga substation is 41 years old and reaching its design capacity. The substation is currently supplied at 22kV and allowance has been made at Transpower Penrose to uprate the substation to 33kV. A short-term solution of using automated load transfer was implemented in 2001. This will defer uprating to 33kV until the load increases above the new design limit or condition monitoring indicates that equipment at the substation needs replacement. Interim solutions have been investigated such as ties between Onehunga and Te Papapa in 2004 with uprating to 33kV in 2012.

A2: Ponsonby and Chevalier Area

Project	*Uprating Ponsonby and Chevalier substations to 11kV*	
Driver	*Growth*	
Timescale	*Within the next 5 years*	
Status	*Subject to load growth*	*Estimated capital $1-3 million*

As outlined in last year's AMP, Ponsonby and Chevalier are the last remaining substations operating at 6.6kV. It is becoming progressively more difficult to maintain security of supply to customers supplied from these substations as the load grows. The uprating will require new transformers for Chevalier, unless suitable surplus transformers become available from elsewhere on the network. Indications are that uprating will need to occur within the next 5 years. Uprating to 11kV is the most cost effective option for increasing the rating of the distribution network. The existing Ponsonby transformers were replaced in 2001 with dual ratio units so these will not require replacing as part of the upgrade.

A3: Kingsland Area

Project	*Replace Kingsland 22kV switchgear*	
Driver	*Performance*	
Timescale	*Within the next 5 years*	
Status	*Subject to condition monitoring*	*Estimated capital $1-3 million*

This switchgear is 38 years old and nearing the end of its technical life. Condition monitoring using partial discharge testing has shown that the equipment remains in satisfactory condition for continued operation. Regular testing will continue and as soon as the results indicate that the condition is such that performance will deteriorate beyond minimum acceptable levels, the switchgear will be replaced. The options to address this issue are limited to replacement of the switchgear.

A4: Ponsonby Area

Project	*Replace 22kV cables*	
Driver	*Replacement*	
Timescale	*Within the next 5 years*	
Status	*Subject to load growth and cable performance*	*Estimated capital $1-3 million*

One of the cables supplying Ponsonby substation is a gas pressure cable which is 38 years old. We are closely monitoring the performance and reliability of all remaining gas cables on our network and we will initiate replacement when condition monitoring confirms actual performance is unacceptable. The other two cables supplying Ponsonby are 53 years old and nearing the end of their technical lives. This project is independent of the 6.6kV uprating project although they could be done at the same time. It is expected that the new cables will be required within the next 5 years.

A5: Chevalier Area

Project	*Replace 22kV cables*	
Driver	*Replacement*	
Timescale	*Within the next 5 years*	
Status	*Subject to load growth and cable performance*	*Estimated capital >$3 million*

One of the cables supplying Chevalier substation is a fluid filled cable which is 23 years old. The other two cables are 72 years old and nearing the end of their technical lives. This project is independent of the 6.6kV uprating project although they could be done at the same time. It is expected that the new cables will be required within the next 5 years.

A6: Manukau Area

Driver	*Growth*	
Timescale	*Within the next 5 years*	
Status	*Proposal*	*Estimated capital <$1 million*

Manukau will require reinforcement or changes to the current operating regime by 2009 if the forecast load growth is realised. Options under review include:

- Installation at Manukau of additional 11kV switchgear and a third 33/11kV transformer
- Increased asset utilisation
- Load management, asset performance analysis and risk evaluation

Interim low cost measures to increase transformer ratings (eg, installation of fans and extra radiators), or automated load transfer facilities will be considered as options, which may provide a worthwhile deferral of the reinforcement expenditure.

A7: Freemans Bay Area

Driver	*Replacement*	
Timescale	*Within the next 5 years*	
Status	*Proposed*	*Estimated capital $1-3 million*

The uprating of Freemans Bay zone substation from 6.6 to 11kV was completed in February 2002. This overcomes the supply problems within the area. However, the 22kV cables supplying Freemans Bay are 35 year old gas pressure cables. VECTOR has recently replaced cables of similar age and technology. The performance of these cables is being closely monitored and we will initiate replacement when condition monitoring confirms actual performance is unacceptable.

Options for the replacement work include:

- New cables from existing supply point (Kingsland)
- New cables from Hobson supply point
- Investigation of constraints caused by 6.6/11kV break line

A8: Hobson Substation

Driver	*Growth*	
Timescale	*Within the next 5 years*	
Status	*Proposed*	*Estimated capital >$3 million*

As the load grows on Hobson substation, a third 110/22/11kV transformer and 110kV GIS will be required to maintain the security of supply. The timing for this is uncertain, and will depend on the decommissioning date of the Quay 110kV cables. These are likely to be commissioned when the eastern highway is constructed.

A9: Quay Substation

Driver	*Growth*	
Timescale	*Within the next 5 years*	
Status	*Proposed*	*Estimated capital <$1 million*

As the load continues to grow on Quay substation, with redevelopment of land around the former railway station, a third 22/11kV transformer will be required at Quay. Load transfers are possible between Quay, Hobson, Parnell, Victoria and Liverpool, and the network will be configured to defer this transformer for as long as possible.

A10: Liverpool/Quay Interconnector

Driver	*Replacement*	
Timescale	*Within the next 5 years*	
Status	*Proposed*	*Estimated capital >$3 million*

The existing gas pressure cable is 37 years old. VECTOR has recently replaced cables of similar age and technology. The performance of this cable is being closely monitored and it is expected that it will be require replacement within the next five years.

A11: Hobson/Quay Interconnector

Driver	*Replacement*	
Timescale	*Within the next 5 years*	
Status	*Proposed*	*Estimated capital $1-3 million*

There are currently four 22kV cables between Hobson and Quay substations. These cables act as a backstop to the main 110kV supply to Quay substation. However, the Quay 110kV gas pressure cables are expected to be retired from service within the next 5 years. The exact timing depends on the condition of the cables but will also be affected by construction of the new eastern arterial road. When these cables are no longer in service, the 22kV cables connecting Hobson and Quay will become the primary supply to Quay, and will need to be replaced to provide the required security.

A12: Takanini Area

Driver	*Growth*	
Timescale	*2008/09*	
Status	*Proposal*	*Estimated capital <$1 million*

There is strong growth in the Takanini area with a prediction of around 2000 houses per annum to be built over the next few years. This will require reinforcement of the capacity at Takanini substation to maintain adequate security of supply.

Options for the reinforcement include:

- New cables from existing supply point (Takanini)
- New 33/11kV transformers
- Additional 33/11kV transformers
- Combination of the above

A13: Hobson West Substation

Driver	*Growth*	
Timescale	*2008/2009*	
Status	*Proposed*	*Estimated capital >$3 million*

Establishment of a new substation to supply increasing load on the western side of the CBD and offload existing substations at Hobson, Victoria and Liverpool was identified as a development option in last year's AMP. The uprating of the Freemans Bay substation to 11kV has allowed interconnection of the network to the western CBD area. This has allowed the proposed substation to be deferred until 2008/09. Load in the area will be monitored to ensure network performance and reliability is maintained, and substation construction will not commence until required.

A14: Ellerslie, Penrose Area

Project	*McNab 11kV switchboard replacement*	
Driver	*Replacement*	
Timescale	*2009*	
Status	*Subject to condition monitoring*	*Estimated capital $1-3 million*

The 11kV switchgear at McNab substation is 50 years old and is nearing the end of its technical life. Condition monitoring using partial discharge testing has shown that the equipment remains in satisfactory condition for continued operation. However, the protection relays on the switchgear have reached the end of their useful life and require replacement, as they no longer provide minimum accepted performance. The options to address this issue are to replace the switchgear including the relays or to only replace the protection relays. Load forecasts indicate replacement of the switchboard will be required in 2009 for reasons of equipment rating.

A15 Sandringham Area

Project	*Replace 22kV cables*	
Driver	*Replacement*	
Timescale	*Within the next 10 years*	
Status	*Subject to load growth and cable performance*	*Estimated capital >$3 million*

The cables supplying the Sandringham 22kV switchboard and Balmoral substation are approaching the end of their economic life. Four of the cables are 61 years old and one is 25 years old. Two of the 61 year old cables have inadequate fault rating. It is planned to replace these cables when necessary with three new 33kV rated cables to Sandringham and two 33kV rated cables to Balmoral. Several options were considered and replacement of the existing cables, operating initially at 22kV with eventual uprating to 33kV was considered the best option. It is expected that the new cables will be required within the next 10 years.

A16: Maraetai Area

Driver	*Replacement*	
Timescale	*Within the next 10 years*	
Status	*Proposal*	*Estimated capital <$1 million*

The 11kV switchgear at Maraetai substation is 45 years old and nearing the end of its technical life. Condition monitoring using partial discharge testing has shown that the equipment remains in satisfactory condition for continued operation. Regular testing will continue and as soon as the results indicate that the condition is such that performance will deteriorate beyond minimum acceptable levels, the switchgear will be replaced. The options to address this issue are limited to replacement of the switchgear.

A17: Parnell Substation

Driver	*Replacement*	
Timescale	*Within the next 10 years*	
Status	*Proposed*	*Estimated capital $1-3 million*

The 22kV cables supplying Parnell substation are 76 years old and nearing the end of their technical life. These are solid PILC cables, and their performance is being monitored. They will be programmed for replacement when their performance deteriorates to an unacceptable level.

A18: Liverpool Substation

Driver	*Replacement*
Timescale	*Within the next10 years*
Status	*Proposed* — *Estimated capital <$1million*

Liverpool substation has three 110/22kV transformers, two of which are 27 years old, and the third is 4 years old. One of the older transformers has undergone a mid-life refurbishment and the second is scheduled for refurbishment in 2003. The condition of the two older transformers will be monitored, and when they reach the end of their technical life they will be replaced. This is expected to be within the next 10 years.

4.5. NORTHERN CUSTOMER AREA

4.5.1. GROWTH IN THE NORTHERN AREA

This area covers the North Shore City, Waitakere City, and Rodney District and includes residential (both rural and suburban), commercial and industrial developments. Most of the commercial and industrial developments are centred around the Albany Basin, Takapuna, Glenfield, Henderson and Te Atatu areas. Areas north of the Whangaparaoa Peninsula and west of Henderson are predominantly rural residential.

Overall the load growth in the region is relatively high at around 2% per annum. The highest load growth in this region is expected to occur around the Albany Basin with the development of industrial and retail businesses. With the opening of the new motorway from North Shore to Orewa (which is planned to be extended to Puhoi), it is expected that significant residential developments will take place in areas north of Silverdale. Demand in established areas is expected to remain relatively static.

4.5.2. ISSUES AND OPTIONS IN THE NORTHERN AREA

N1: Northern Area

Project	*Uprate various 33kV circuits*
Driver	*Growth*
Timescale	*2004*
Status	*Proposed* — *Estimated capital >$3 million*

Due to load growth in the area the existing conductor on several 33kV circuits is constraining capacity. Replacement with a larger conductor provides an economic way to defer major capital expenditure. The affected circuits are:

- Albany-Coatesville
- Helensville-Silverdale
- Hepburn-Henderson Valley
- Wairau-Birkdale
- Albany-James Street
- Wairau-James Street
- Wellsford-Warkworth

N2: Albany Basin Area

Project	*Establish a 33kV bus at Bush Road substation*	
Driver	*Growth*	
Timescale	*2004*	
Status	*Proposed*	*Estimated capital $1-3 million*

The two transformers at Bush Road are fed from the Albany Grid Exit Point via a radial circuit and a tee off from the Albany - Sunset Road circuit. Security will be enhanced by installing a third transformer and 33kV feeder to the substation. The installation of a 33kV switchboard will allow better utilisation of the feeder capacity and improve operational flexibility of the network.

N3: North Shore Area

Project	*33kV cable to Forest Hill substation*	
Driver	*Growth*	
Timescale	*2004*	
Status	*Subject to cross isthmus project*	*Estimated capital >$3 million*

The installation of a 33kV Cable from Sunset Road to Forest Hill and reconfiguration of the 33kV network. This will enable the 110kV reinforcement at Wairau Road to be deferred for a number of years. This project will need to be reviewed when more definite information regarding the cross isthmus project becomes available.

N4: Whangaparaoa Area

Project	*Establish Gulf Harbour substation*	
Driver	*Growth*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital >$3 million*

Demand on the Whangaparaoa Peninsula has been growing steadily and due to the geographic layout, backup supplies are limited. Over recent years, incremental capacity enhancements such as the dual rating of zone substation transformers have been implemented to defer major reinforcement. The stage has now been reached where additional 33kV and 11kV capacity is required to maintain the level of security. A new zone substation will be established at Gulf Harbour, which includes the installation of a 33kV cable from Manly zone substation to the Gulf Harbour zone substation site.

N5: Henderson Area

Project	*Establish Keeling Road substation*	
Driver	*Growth*	
Timescale	*2004*	
Status	*Proposed*	*Estimated capital >$3 million*

The Henderson/Sturges Road area requires reinforcement due to steady load growth. Options reviewed included, installation of a second transformer at Woodford substation and installation of a third transformer at Henderson Valley substation and establishment of a new zone substation in Keeling Road. Analysis concluded that the Keeling Road option provides the best long term outcome.

N6: Albany Basin Area

Project	*33kV cable to Sunset Road substation*	
Driver	*Growth*	
Timescale	*2005*	
Status	*Subject to load growth*	*Estimated capital $1-3 million*

Growth in the Albany Basin means that reinforcement and changes in the operating regime will be required to maintain the security of supply. To enhance the security of supply at Wairau Road, load will be transferred from Wairau Road to Sunset Road and the 33kV capacity into Sunset Road will be reinforced to accommodate this.

N7: Henderson Area

Project	*Reconfigure the Henderson area 33kV network*	
Driver	*Growth*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital <$1 million*

The presence of a number of tee off and spur line arrangements on the 33kV network in the area has resulted in performance issues. It is proposed to address these issues by reconfiguring the network.

N8: Albany Basin Area

Project	*33kV cable to McKinnon substation*	
Driver	*Growth*	
Timescale	*2006*	
Status	*Subject to load growth*	*Estimated capital $1-3 million*

Following reinforcement and changes to the operating regime, reinforcement of the Browns Bay 33kV ring network is required to maintain security of supply. Options include:

- Installation of a 33kV cable from Albany Grid Exit Point to McKinnon substation
- Installation of a 33kV cable from Albany Grid Exit Point to Browns Bay substation

Load flow analysis shows that a higher level of security will result from installing a 33kV cable to McKinnon substation.

N9: Silverdale Area

Project	*Establish new Silverdale North zone substation*	
Driver	*Growth*	
Timescale	*2006*	
Status	*Subject to growth*	*Estimated capital $1-3 million*

With the extension of the Northern motorway towards the Silverdale/Orewa area, demand is expected to grow steadily. Forecasts indicate that additional 33/11kV capacity will be required in about five years time. Options include the establishment of a new zone substation in the north Silverdale area, establishment of a new zone substation at the Transpower Silverdale Grid Exit Point site, or extending the 11kV network from Spur Road zone substation.

N10: Greenhithe Area

Project	*Establish Greenhithe substation*	
Driver	*Growth*	
Timescale	*2007*	
Status	*Subject to load growth*	*Estimated capital >$3 million*

As the demand in the Greenhithe area increases through residential development, there will be a need to increase the 11kV capacity to maintain the security of supply in the area. As this area is already supplied by long 11kV feeders from remote zone substations, extending the 11kV network does not provide sufficient security of supply or an economic solution to the issue. It is proposed to establish a new zone substation.

N11: Whangaparaoa Area

Project	*33kV cable to Manly substation*	
Driver	*Growth*	
Timescale	*2007*	
Status	*Subject to growth*	*Estimated capital >$3 million*

As demand in the Whangaparaoa Peninsula continues to grow, reinforcement will be required to maintain security of supply. Due to the geographic location of the area, backup from the 11kV network is limited. Options under consideration include the uprating of the existing submarine cables or installation of a new 33kV circuit. The 33kV circuit would provide a long term solution, but is dependant upon the construction of the toll bridge. We will continue to assess these options in line with Transits plans.

N12: New Lynn Area

Project	*Reinforce 33kV capacity at New Lynn substation*	
Driver	*Growth*	
Timescale	*2008*	
Status	*Subject to growth*	*Estimated capital $1-3 million*

As the demand around the New Lynn area increases, reinforcement is required to enhance the security of supply. Various options have been considered including include the installation of additional 11kV ties between Sabulite Road and New Lynn and between Sabulite Road and McLeod Road to enable load transfer from the 33kV group, or reinforcement of the 33kV ring by adding a new 33kV cable. The 11kV option was discarded as it involved complicated switching operations, in addition to not providing a long term solution. A 33kV cable will be installed between Sabulite and New Lynn zone substations.

N13: North Shore Area

Project	*4th 110kV circuit to Wairau Road substation*	
Driver	*Growth*	
Timescale	*2008*	
Status	*Subject to cross isthmus project*	*Estimated capital >$3 million*

In recent years, a series of small capital projects has been initiated to maintain the security of supply in the area. In the next five to ten years, demand will grow to an extent that further reinforcement is required. Options for reinforcement include installing a fourth 110kV feeder to Wairau Road substation, or installing 220/33kV transformers at Wairau Road, supplied from the proposed 220kV cross isthmus cables. This project will be reviewed when more definite information regarding the cross isthmus project becomes available. In the meantime, planning will be based on the fourth 110kV transformer feeder option.

N14: Whangaparaoa Area

Project	*Install a second 33kV cable from Manly substation to Gulf Harbour substation*	
Driver	*Growth*	
Timescale	*2008*	
Status	*Subject to growth*	*Estimated capital $1-3 million*

As load continues to grow in the Whangaparaoa area it will become progressively more difficult to maintain sufficient security of supply. As a long term solution, a 33kV cable (initially operating at 11kV) will be installed from Manly to Gulf Harbour to relieve the heavily loaded 11kV network. This will eventually be used to supply a second transformer at Gulf Harbour substation.

N15: Albany Basin Area

Project	*East Coast Road, second transformer*	
Driver	*Growth*	
Timescale	*2009*	
Status	*Subject to load growth*	*Estimated capital $1-3 million*

As the demand in the Albany Basin/Browns Bay area increases, reinforcement of the 11kV capacity will be required to maintain the security of supply in the area. Options include:

- Installation of a second transformer at East Coast Road substation
- Establishment of a new substation near P79 along East Coast Road

Economic analysis has shown that the installation of a second transformer at East Coast Road substation is the preferred option.

N16: Henderson Area

Project	*Keeling Road substation to Woodford substation 33kV tie*	
Driver	*Growth*	
Timescale	*2009*	
Status	*Subject to growth*	*Estimated capital $1-3 million*

Due to load growth around the Henderson Valley area, a 33kV tie line between the Woodford and Keeling Road substations, which currently are supplied by single 33kV radial circuits, will be required to maintain sufficient security of supply.

N17: North Shore Area

Project	*Highbury substation second transformer*	
Driver	*Growth*	
Timescale	*2009*	
Status	*Subject to growth*	*Estimated capital >$3 million*

There is steady load growth in the Highbury/Northcote area. The establishment of Takapuna zone substation in 2001 enabled both Hillcrest and Northcote zone substations to be offloaded as an interim measure. However, additional 11kV capacity will be required towards the end of the planning period. Options include installation of a second transformer at Northcote, Highbury or Balmain substations. The Highbury option is currently preferred as additional capacity located there can be used to backup the other two zone substations.

N18: Albany Basin Area

Project	*McKinnon substation and transformer*	
Driver	*Growth*	
Timescale	*2011*	
Status	*Subject to growth*	*Estimated capital $1-3 million*

As the demand around the Albany Basin industrial area increases, reinforcement of the 11kV capacity will be required to maintain the security of supply in the area. As the area is predominately commercial/industrial, demand management is not a viable option. It is proposed to install a second transformer at McKinnon substation, with related 33kV network reinforcement.

4.6. WELLINGTON CUSTOMER AREA

4.6.1. GROWTH IN THE WELLINGTON AREA

The Wellington area covers the Cities of Wellington, Porirua, Lower Hutt and Upper Hutt.

Wellington City is one of the major metropolitan centres in the country with high-density commercial developments. The Wellington CBD is by far the most significant business and retail centre in the region. There are also business and retail centres scattered around the area at Lower Hutt, Porirua, Upper Hutt, Seaview, Gracefield, Petone and Johnsonville. Small industries and warehouse developments centre along the Lower Hutt, Ngauranga Gorge, Petone, and Naenae areas.

Overall demand growth in the region is expected to be low with most of the growth expected to take place around the Wellington CBD area.

4.6.2. ISSUES AND OPTIONS IN THE WELLINGTON AREA

W1: Wellington CBD/CBD Fringe

Project	*Reinforcement of the 33kV capacity to zone substations*	
Driver	*Growth*	
Timescale	*2004-2012*	
Status	*Subject to assessment of cable ratings*	*Estimated capital >$3 million*

Revaluation of the ratings of 33kV cables has confirmed that in some areas the cable ratings are significantly less than previously thought. To mitigate this problem a new circuit will be installed to each zone substation, and the two existing cables to each zone substation will be run in parallel. This will also enable better utilisation of the existing transformer capacity. The affected zone substations are:

- The Terrace
- Moore
- University
- Frederick Street
- Palm Grove
- Johnsonville
- Mataitai
- Karori
- Waikowhai

W2: Wellington CBD

Project	*Establish Bond Street substation*	
Driver	*Growth*	
Timescale	*2012*	
Status	*Subject to growth*	*Estimated capital > $3 million*

As the demand in the Wellington CBD and the fringe areas grows, reinforcement will be required to maintain the security of supply in the area. A site has already been reserved in the area for a new zone substation.

W4: Hutt Valley

Project	*Replace Melling ripple injection plants*	
Driver	*Performance*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital <$1 million*

The existing rotary injection units are 45 years old, situated on the flood plain and have insufficient signal strengths in certain areas. A new static plant will be installed within the Transpower substation.

4.7. TRANSFORMER REDEPLOYMENT

To ensure optimum utilisation of existing assets, transformers are relocated when released if performance and condition criteria are met. The Hobson and Onehunga projects will release the following transformers:

- Hobson transformers: 2x22/11kV units to be relocated to Chevalier
- Existing Chevalier 22/6.6kV units to be scrapped
- Onehunga 22/11kV transformers to be scrapped

Other transformers to be relocated include:

- Mangere Central 33/11kV transformer to be relocated to Manukau
- Spare 110/22kV transformers to be relocated to Liverpool

4.8. TRANSPOWER SUPPLY POINTS

Transpower supplies the VECTOR network through 21 grid exit points. Transpower and VECTOR liaise on works programmes to ensure priority and critical issues are addressed.

4.8.1. ISSUES AND OPTIONS AT THE GRID EXIT POINTS

Wiri Grid Exit Point

Driver	*Security of supply and performance*
Timescale	*2002/03*
Status	*Completed*

As discussed in the 2002 AMP, an increase in transformer capacity was required at Wiri given that load growth in the area is expected to continue. The existing 50MVA transformer was replaced with a 100MVA transformer redeployed from Pakuranga in April 2003.

Mangere Grid Exit Point

Driver	*Security of supply and performance*
Timescale	*2003*
Status	*Completed*

As discussed in the 2002 AMP, security of supply at Mangere is vital because of the critical customers supplied from there (Middlemore Hospital, Watercare sewage treatment plant, and Auckland International Airport). Transpower has installed a 110kV bus section circuit breaker and 110kV bus zone protection.

Silverdale Grid Exit Point

Driver	*Growth and Quality of supply*
Timescale	*2003*
Status	*Committed*

The demand at Albany has grown to the extent that the firm capacity is exceeded. Also, the 33kV network from Albany that supplies the industrial developments at Albany also supplies the extensive rural areas north of Albany. As a result the newly developed industrial areas in Albany are experiencing power quality issues. A decision was made to establish a new 220/33kV point of supply at Silverdale which is scheduled to be commissioned in late 2003. The rural network supplying Manly, Orewa, Spur Road and Helensville substations will be transferred to this new point of supply.

Central Park Grid Exit Point

Driver	*Growth and Security of supply*
Timescale	*Within the next 2 years*
Status	*Committed*

The age and condition of the existing 110/11kV transformers has prompted the need for replacement. Due to space limitation on the site, reinforcement of the 33kV capacity needs to be considered at the same time. A long-term solution involving installation of a third 110/33kV transformer and replacement of the 110/11kV transformer with 33/11kV units has been agreed with Transpower.

Hepburn Grid Exit Point

Driver	*Security of supply*
Timescale	*Within the next 5 years*
Status	*Proposal*

The existing transformer capacity at Hepburn is insufficient to meet the Transpower reliability standard although there is sufficient back up capacity from within the 33kV and 11kV networks for the next few years. A proposal to install a third 110/33kV 50MVA transformer at Hepburn is being considered.

Penrose Grid Exit Point

Driver	*Security of supply*
Timescale	*> 2006*
Status	*Discussion*

There are current concerns over the security of the 220kV supply into Penrose. Options to address this issue are currently being studied jointly with Transpower.

4.9. CUSTOMER INITIATED NETWORK DEVELOPMENTS

Customer initiated capital expenditure is driven primarily through the growth of the city and with Auckland and Manukau cities being some of the fastest growing areas in New Zealand, VECTOR experiences a significant level of the following growth related activities:

- New subdivisions account for around 40% of customer activity, including reticulation and streetlighting for commercial and residential developments

- New service connections in areas where reticulation already exists or only requires moderate extension account for a further 20% of expenditure
- Customer substations are installed for commercial customers with loads unable to be supplied from the low voltage reticulation

The remainder of the expenditure is divided between:

- Cable relocations – mainly driven by council road widening projects
- Capacity changes – where transformer-connected customers require an upgrade or downgrade in capacity
- Low voltage reinforcements – where a change in customer capacity requires an upsizing of the low voltage network

The demands from the customer led initiatives are included in the load forecasts and influence the timing and priority of capital works in the VECTOR network.

4.10. NETWORK PERFORMANCE PROJECTS

Fibre Optic Cable Extensions

Driver	*Growth*
Timescale	*Ongoing*
Status	*As required*

The fibre optic cables are used for operational communication, network control and protection signalling. It is proposed to extend VECTOR's fibre optic network backbone to connect all Transpower points of supply in VECTOR's area. Any new zone substation built will be connected to the Transpower point of supply via fibre optic cable. To minimise costs, use is also made of fibres installed by others across the network.

4.11. EXPENDITURE FORECAST

The capital expenditure plan that corresponds to the asset replacement, refurbishment and development projects is given in Table 4.1. These forecasts are based on known and current solutions only. Extensive analysis of alternate approaches, including load management, increased asset utilisation through advanced technology etc is expected to enable the forecast expenditure to be reduced.

Network projects include:

- Compliance projects where the main drivers are regulatory, environmental, health and safety etc

- Growth projects where the main drivers relate to growth in demand

- Performance projects where the main driver is replacement of assets in order to improve network reliability and/or reduce maintenance costs

- Replacement projects where the main driver is replacement of assets that are at the end of their useful life, or where the whole of life maintenance and remedial costs are higher than the replacement costs. Risk analysis is another key driver in this category

	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/12
Network	42	48	54	57	58	31	29	29	35	33
OIP	25	10	10	10	10	10	10	10	10	10
Customer	25	25	25	25	25	25	25	25	25	25
TOTAL	92	83	89	92	93	66	64	64	70	68

Table 4.1 Forecast Capital Expenditure Budget ($ million)

5. ASSET MAINTENANCE

5.1. ASSET MAINTENANCE STRATEGY

VECTOR operates and manages a wide range of assets from 110kV power transformers to 230V service connections. Each asset is managed in terms of risk and criticality and the optimum maintenance strategies defined.

Ensuring that the asset maintenance, refurbishment and replacement programmes are value-based is the critical driver in VECTOR's asset management policy. Asset maintenance can be a significant proportion of the total lifecycle cost and VECTOR's approach is one of value-based maintenance.

This section gives an overview to VECTOR's approach to maintenance, asset renewal and replacement, but this may change as the Commerce Commission finalises its threshold regime. The outcome of this regulatory interface will clarify and define the quality and price path VECTOR takes, influencing our strategy, approach to targeting customer segments and our investment profile.

The current foundation for the asset maintenance plan are the customer service targets, which are based on customer type and service expectations in the Auckland network and network reliability targets in the Northern and Wellington networks. The decisions on maintenance for each asset are based on their impact on the reliability targets, fault frequency, duration of outages, power quality, health and safety implications, reliability management and cost. Asset maintenance, refurbishment and replacement on the VECTOR network are designed to maintain the functionality of the asset and the operating capability of the network to meet these requirements.

The asset management practices, maintenance regimes and initiatives trialed in recent years are very similar between the three network areas for the subtransmission assets. Because of this, the subtransmission asset sections are written for VECTOR as a whole.

There are however significant differences in the initiatives trialled between the three networks in the overhead and underground distribution assets. This reflects differing asset bases and differing risk and priority analysis. This difference in approach has provided VECTOR with a large data set of asset failure modes, risks and success statistics for initiatives. We will use this information to evaluate:

- The likelihood of similar risks in other network areas; and
- The benefits of implementing similar strategies in other network areas to achieve improvements in reliability or safety

The effectiveness of these initiatives will be monitored to determine success rates and any secondary risk exposures before deciding on further expansion or implementation strategies.

Because of the differences in approach the improvements for reliability and safety for the distribution assets are split into the Auckland, Northern and Wellington networks. Asset maintenance and replacement practices are very similar and are not broken down at the network area level.

In general, in all network areas preventative maintenance on VECTOR's network consists of the following:

- Routine asset inspections, condition assessments, servicing and testing of assets
- Evaluation of the results in terms of meeting customer service levels, performance expectations, risks etc
- Repair, refurbishment or replacement of assets when required

Asset maintenance criteria are documented in the service providers and VECTOR's maintenance instructions and standards. These include the inspection, testing and condition assessment requirements for each asset. The maintenance instructions also include the actions to be taken based on the results of the tests and condition assessments.

The development of the asset maintenance plans takes into account the variety of customer, environmental, operational performance and condition factors. Generic maintenance actions are developed for each asset type, but can be applied differently based on asset performance requirements and criticality. Together with our service providers, we regularly review the maintenance requirements for individual assets or areas, supported by information updates and refine and optimise the maintenance plans. Assets that are at a greater risk of a certain type of failure or have high utilisation or high risks associated with failure can have enhanced preventative and condition based maintenance schedules. Similarly, areas with known asset problems or fault causes can have enhanced maintenance or monitoring programmes implemented.

As a general rule, the timing for any replacement is based on condition and performance assessments made as the asset:

- Approaches the end of its useful life and is no longer suitable for its application, in terms of asset functionality or customer requirements
- When the asset presents an unacceptable risk for performance or to the operating and maintenance personnel
- For economic reasons if the whole of life maintenance or remedial costs are higher than the expected replacement costs or monitoring dictates the risk is unacceptable

From the detailed inspections and condition assessments, it has been determined that the condition of certain assets means that replacement or refurbishment is necessary to maintain the functionality of the asset. In line with our approach to value-based maintenance, asset refurbishment or replacement programmes are applied to address known condition or performance issues for certain groups of assets in a particular area or environment and/or monitoring is stepped up. This further refines our existing replacement strategy and will enable full analysis of the economic and life cycle benefits of individual assets against groups of asset replacement programmes.

The underlying objective is to identify opportunities to achieve, where appropriate, overall value through programmes of replacement rather than incurring remedial and ongoing preventative maintenance costs. It is recognised that asset types have a finite life and for some asset types there may be a point where fault rates or performance degradation start increasing at such a rate that ongoing maintenance is uneconomic.

One of the major factors considered is whether an asset's condition is regularly monitored through inspection or testing, versus assets where it is not possible or practical to inspect. The relative cost of inspection when compared to the replacement cost is also a consideration. Where the cost of inspection is low, or there are low volumes of assets and the cost of replacement is high, replacement on an individual asset basis is most likely to be the approved method. For assets where condition inspection is not possible, or the costs of inspection are prohibitive, replacement will be driven by age or by fault rate analysis, and are more likely to be comprehensive than specific.

5.1.1. FAULT ANALYSIS

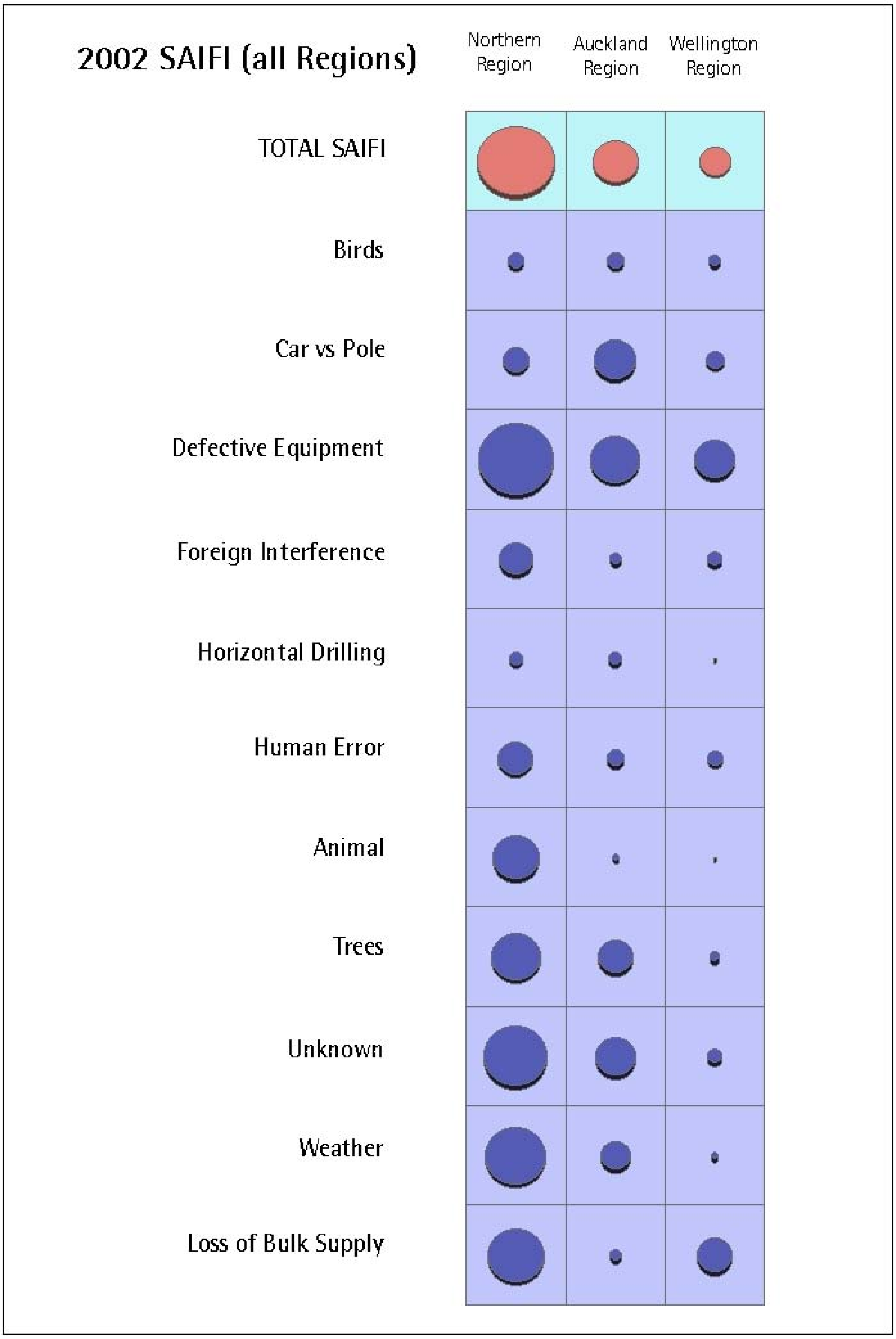


Figure 5.1 GIS Analysis Data - SAIFI

Analysis of faults, their impact in terms of frequency and duration, their costs and impact on customer service targets is a fundamental part of our asset maintenance strategy.

Figure 5.1 shows the HV SAIFI profiles by fault type for 2002 for each network. Reducing SAIFI will be a challenge and require focussed asset management to ensure customer service and reliability targets are maintained.

Targeted initiatives from last year have had significant success. In the Auckland network 7% of SAIFI was caused by human error. By working with our service providers to review switching practices, this has been reduced to 3%. We will continue to keep up pressure in this area to ensure focus is retained.

Trees still remain a problem: targeted preventive maintenance will improve this, but in some areas where cutting is not an option, small scale undergrounding or reconductoring with ABC/CCT will be considered. Defective equipment represents 27% of SAIFI across the networks and targeted asset replacement, where appropriate, through our capital programme should reduce this impact.

To ensure asset management is value-based, all proposed repair, refurbishment and replacement work is assessed to ensure that the rationale fits with one or more of the following drivers:

- Safety and environmental issues
- To bring performance in line with customer or performance targets
- Work will result in a cost saving
- Customer wants and is willing to pay for improved performance

No work proceeds without value analysis to determine the most cost effective solution to achieve the required level of performance.

When the requirement arises for an asset to be replaced, the opportunity is taken to consider the justification for both an upgrade and/or capacity increase to meet future supply requirements and replacement with modern technology to ensure minimum asset lifecycle costs. VECTOR is continually reviewing equipment for use on the network in terms of whole of life costs, which include reliability, initial costs and ongoing maintenance and operational costs.

5.2. ASSET PROCESS

For any asset replacement or refurbishment decision the process outlined in Figure 5.2 is followed to ensure consistency and comparability of options across the network areas and across the range of project types VECTOR manage.

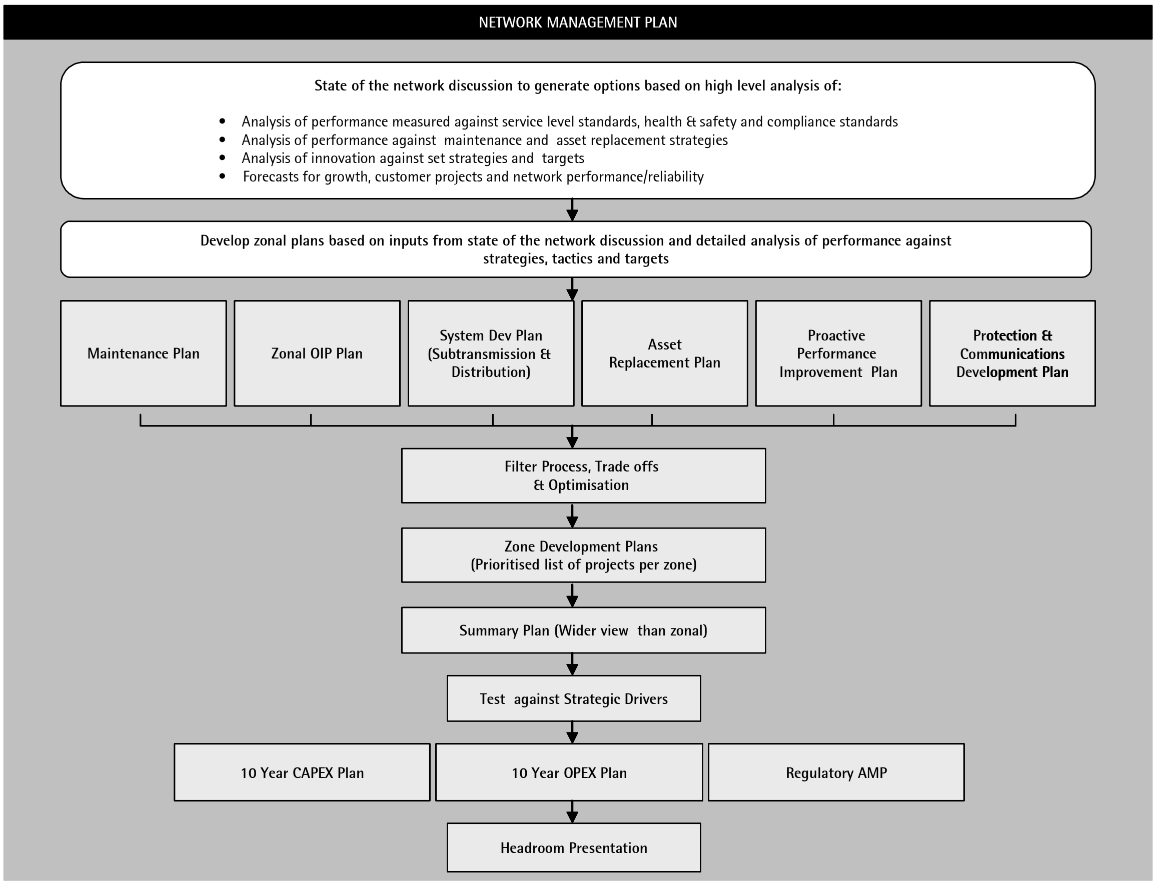


Figure 5.2 Asset Decision Process

5.3. ASSET MAINTENANCE BY ASSET TYPE

In this section the following terms are used:

Asset description
A brief description of the asset.

Asset performance and condition
Design capacity and current utilisation. Age profiles and condition based test investigations. Improvements for reliability and safety made in 2002/03.

Asset maintenance
Brief description of the generic planned maintenance activities.

Asset issues and risks
Indication of asset specific risks, their impacts, current controls and planned actions.

Asset replacement
Major work that does not increase the capacity of the asset, but maintains the capacity and functionality of the asset at its lowest whole of life cost.

5.4. TRANSMISSION AND SUBTRANSMISSION CABLES AND LINES

5.4.1. ASSET DESCRIPTION

The subtransmission network consists of 1,193km of cables and lines rated at 110kV, 33kV and 22kV as detailed in Table 5.1.

Cable Type	110kV	33kV	22kV	Total Length (km)
Overhead	28	492	3	522
Underground PILC	0	181	68	249
Underground XLPE	27	169	18	215
Underground Fluid Filled	26	123	25	174
Underground Gas Pressurised	20	0	12	32
TOTAL by Voltage	101	965	126	1,193

Table 5.1 Transmission and Subtransmission Cable Lengths and Voltages

5.4.2. ASSET PERFORMANCE AND CONDITION

Improvements for Reliability

Joint Testing
A new x-ray methodology has been developed for assessing the condition of a joint in-situ without destroying the integrity of the joint. The technique was developed to identify thermomechanical movement of cores in cable joints (primarily fluid/gas types). Although still in the experimental stage, the methodology has been used successfully on a number of different cable types. The technique will continue to be developed and used where appropriate.

Cable Ratings
Cable rating has been extended to calculate long-term cyclic and short-term emergency loadings for all subtransmission cables, based on identified hot spots. These ratings are used as the basis for determining future network reinforcement options. The ratings also provide more accurate limits for network operations, and provide information to support consideration of short-term off load options in emergency situations, which improves asset utilisation. Research

to improve the accuracy of the models continues. This includes comparing actual measured cable temperatures with calculated values, and improved condition testing procedures for measurement of soil thermal resistivity. To facilitate this, Distributed Temperature Sensing (DTS) has been installed to enable continuous temperature monitoring and enables the exact location of hot spots. DTS is a relatively new technology and VECTOR is working with CIGRE to develop standards for the DTS equipment and cable rating techniques.

All new subtransmission cables have optical fibres within or attached to them, to enable future connection to DTS monitoring.

In a number of sites where cable capacity was restricted due to soil resistivity problems, soil has been replaced with a more suitable thermal backfill and/or ducts have been filled with bentonite (thermal slurry).

Partial Discharge Tests
Trials are being conducted this year to investigate the use of on-line partial discharge location and monitoring on our cables. The tests will show fault locations enabling repairs to be actioned efficiently and also assist in determining the ability of the cable to handle increased loading, potentially deferring capital investment. If the trials are successful, the test will become part of the base maintenance on our cables.

110kV Radio Frequency Interference Reduction
Following an increasing number of localised radio frequency interference problems on the 110kV lines, investigations have shown that the insulator assembly pivoting clamps as the problem source. Using in house solutions replacement clamps have reduced the RFI to well below statutory levels.

5.4.3. ASSET MAINTENANCE

- Regular route patrols, with enhanced frequency in parts of the CBD, to identify any potential problems in the Auckland network
- Proactive work with external service providers to prevent third party damage
- Annual cable termination inspections and thermographics
- Serving tests

5.4.4. ASSET ISSUES AND RISKS

No new issues or risks have been identified for the subtransmission cable and line assets this year.

5.4.5. ASSET REPLACEMENT

Cables

The various cables have varying design lives but the main criteria for transmission and subtransmission cable replacement are an assessment of the risk of loss of functionality, analysis of failure rates and costs and condition tests. Condition and performance are used as the main guideline for replacement. The fluid filled and gas cable pressures are continuously monitored via the SCADA system, with alarms to give early warnings of falling pressure.

5.5. TRANSMISSION AND SUBTRANSMISSION TRANSFORMERS

5.5.1. ASSET DESCRIPTION

VECTOR owns 244 transformers, two of which are at Lichfield, which lies outside of VECTOR's main supply networks. The subtransmission transformers range in rating from 5MVA to 65MVA. The age profile of the subtransmission transformers is shown in Figure 5.3.

The ODV design life of a transformer is 45 years, but if the transformer is not subject to abnormal operating conditions and is well maintained, the design life can be extended.

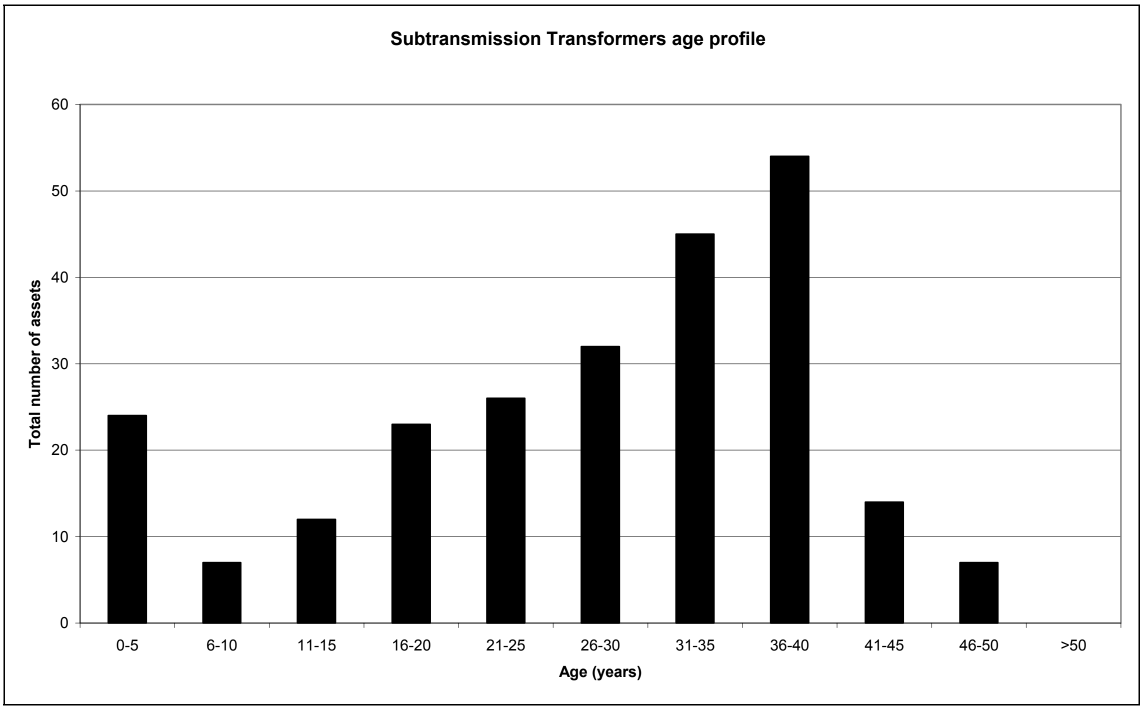


Figure 5.3 Subtransmission Transformers Age Profile

5.5.2. ASSET PERFORMANCE AND CONDITION

Improvements for Reliability

Tap Changer Condition

Following successful trials of the Tap Changer Activity Signature Analysis (TASA) condition assessment method, all future maintenance requirements for tap changers will be determined by this test. In the Auckland network this has been implemented as part of ongoing preventative maintenance and we plan to replicate this in the Northern and Wellington networks.

5.5.3. MAINTENANCE

Routine condition monitoring of transformer components is carried out using non-invasive methods. Each transformer is subject to monthly visual checks for moisture, oil levels and leaks, and fan operation.

On an annual basis, DGA and TASA tests for transformer and tap changers are carried out, along with alarm tests, Buchholz relay tests and thermal and ultrasonic imaging of terminations and connections.

The timing for the transformer refurbishment is scheduled based on DGA and other condition assessment results. Transformers scheduled for movement to another site are refurbished as part of the move where their condition and assessed remaining useful life makes this an economic option. Trials will be conducted this year using the TJH2b TCA Transformer Condition Assessment programme for complete analysis of transformer oil, and if proven successful it will be introduced as an alternative to the standard DGA tests within the preventative maintenance routine.

5.5.4. ASSET ISSUES AND RISKS

No new issues or risks have been identified for the transformer assets.

5.5.5. ASSET REPLACEMENT

Transformer replacement is based on condition. Transformers or components that have deteriorated beyond acceptable parameters are taken out of service for a detailed inspection of moisture levels, the core and windings. The investigation gives an indication of life expectancy of the transformer and a decision is made on refurbishment or replacement based on the functionality and performance requirements of the asset.

5.6. TRANSMISSION AND SUBTRANSMISSION SWITCHGEAR

5.6.1. ASSET DESCRIPTION

VECTOR owns and operates 1,788 subtransmission circuit breakers, rated at 110kV, 33kV, 22kV, 11kV and 6.6kV. The circuit breakers are oil, vacuum, SF_6 and Gas Insulated Switchgear (GIS). Figure 5.4 shows the age profile of circuit breakers.

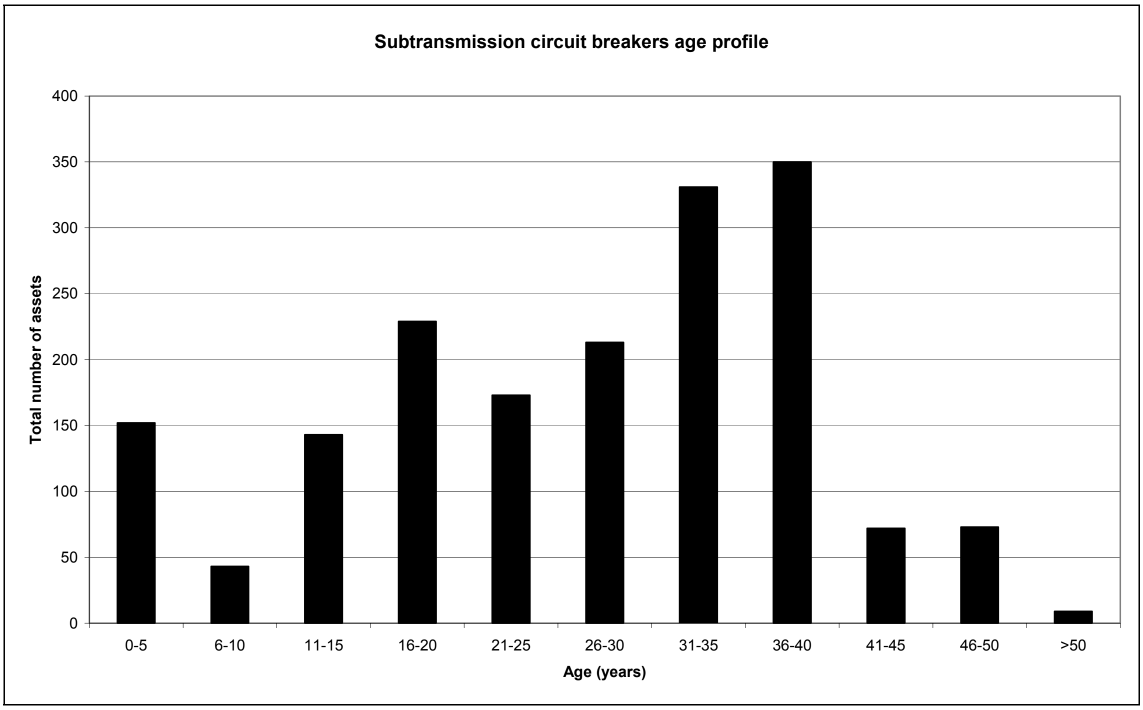


Figure 5.4 Subtransmission Circuit Breakers Age Profile

Improvements for Reliability

OKW3 Circuit Breaker Replacement

The replacement programme for OKW3 circuit breakers in the Northern and Wellington networks is nearing completion and has resulted in significant improvement in the clearing of faults and associated power loss issues.

5.6.2. ASSET PERFORMANCE AND CONDITION

The condition of the circuit breakers is generally good with no new condition problems identified through maintenance or operation.

5.6.3. MAINTENANCE

- All switchgear is visually inspected on a monthly basis for leaks and general condition
- Thermographic examination is undertaken on all switchboards annually
- Kelman profile testing and non-invasive partial discharge location and monitoring is carried out on a two yearly cycle
- Major maintenance on the switchgear including inspection and performance testing of the circuit breakers and testing of the protection relays and systems on an eight year cycle

5.6.4. ASSET ISSUES AND RISKS

No new issues or risks have been identified for the switchgear assets.

5.6.5. ASSET REPLACEMENT

Circuit breaker replacement is based on condition.

5.7. ZONE SUBSTATION BUILDINGS

5.7.1. ASSET DESCRIPTION

There are 121 zone substations in the VECTOR network.

5.7.2. ASSET PERFORMANCE AND CONDITION

The buildings and grounds are in functional condition. Any minor issues are dealt with as routine repairs.

Improvements for Reliability and Safety

Zone Substation Revitalisation
Following the identification of asbestos in some zone substation ceilings within the Auckland network an asbestos removal programme was adopted in accordance with the OSH guidelines for the management and removal of asbestos. All high and medium risk sites have been completed, and low risk sites are scheduled to be completed by 2003/04.

Earthing System Upgrades and Seismic Upgrades
Work on earthing system and seismic upgrades are now complete in the Auckland network and on target to be completed by 2009/10 in the Northern and Wellington networks.

Oil Containment

Oil containment is required to comply with the Resource Management Act requirements to prevent stormwater containing contaminants (oil) from being released to the environment. The programme is ongoing and on target to be completed in the Auckland network by 2003/04 and the Northern and Wellington networks by 2009/10.

All new substations have roofs over the transformer bays and have specifically designed oil containment bunds. Existing substations are being upgraded by the installation of a combination of roofs/bunds or oil plate separators, depending on which option is more effective at a particular site.

5.7.3. ASSET MAINTENANCE

All zone substations and grounds and ripple injection spaces are maintained with regard to access security, condition and safety. The routine inspections include the building and other assets such as lighting, fire systems, fans, heaters and safety equipment.

5.7.4. ASSET ISSUES AND RISKS

No new issues or risks have been identified for the zone substation assets.

5.8. PROTECTION AND CONTROL: RELAYS

5.8.1. ASSET DESCRIPTION

VECTOR operates over 5,200 relays. 88% of the relays are electromechanical, 6% solid state and 6% numerical.

5.8.2. ASSET PERFORMANCE AND CONDITION

The condition of the relays is good, with the exception of one particular model of solid state relay (Nilstat ITP) in the Auckland network.

Improvements for Reliability

Digital Relays

To provide an enhanced protection signalling distance and directional over current scheme, a number of electromechanical relays were replaced last year in the Northern and Wellington networks.

5.8.3. MAINTENANCE

Electromechanical relays are tested on a four year basis.

Solid state relays of the Nilstat ITP type are tested an annual basis, to monitor the condition prior to replacement.

Numerical relays are equipped with self-diagnostic functions, but international experience has shown that not all protection relay faults can be detected by the self-monitoring functions; therefore VECTOR has adopted the recommendations on testing numerical protection relays from the CIGRE Study Committee 34 Power System Protection and Local Control.

5.8.4. ASSET ISSUES AND RISKS

No new issues or risks for the relay assets have been identified for the relay asset group.

5.8.5. ASSET REPLACEMENT

Individual replacement of relays is based on as failed and asset replacement programmes are based on condition.

5.9. PROTECTION AND CONTROL: DC AUXILLIARY SUPPLY

5.9.1. ASSET DESCRIPTION

Each zone substation is equipped with DC auxiliary systems to provide the power supply for protection, metering, communication and control devices, including the circuit breakers closing and tripping circuits. The major substations are equipped with a redundant DC system.

VECTOR has battery banks at all zone substations and some HV customer substations to provide tripping and closing supply to the circuit breakers. Batteries also provide standby power supplies for the relays, SCADA, metering and communication equipment.

5.9.2. ASSET PERFORMANCE AND CONDITION

Improvements for Reliability and Safety

All batteries have now been replaced with Valve Regulated Lead Acid (VRLA) batteries in the Auckland network. The VRLA batteries are industry standard, remove the environmental risks associated with the NICAD and are a more cost effective option.

5.9.3. MAINTENANCE

Maintenance for the VRLA batteries is based on the recommendations of IEEE–1188 (IEEE Recommended Practice for Maintenance, Testing and Replacement of Valve Regulated Lead Acid Batteries for Stationary Applications).

5.9.4. ASSET ISSUES AND RISKS

No new issues or risks have been identified.

5.9.5. ASSET REPLACEMENT

In all networks batteries are replaced when failed or based on condition assessment results with VRLA batteries.

5.10. COMMUNICATIONS AND CONTROL: SCADA

5.10.1. ASSET DESCRIPTION

The existing SCADA system consists of three sub systems, the main SCADA system, the ripple control RTU's at the grid exit points and the grid exit point metering system. Control systems for all network areas are now based in Auckland.

5.10.2. ASSET PERFORMANCE AND CONDITION

Improvements for Reliability and Safety

The protection system and corresponding communication links on the Northern network have been replaced with a 31km high bandwidth fibre optic backbone which enables the Control Centre to be linked to all zone substations. This replacement is delivering improved availability and reliability and is a key step in moving towards intelligent monitoring and control.

5.10.3. MAINTENANCE

The main SCADA system is self-diagnostic in terms of failure being immediately apparent in the Control Room. The existing SCADA RTU's do not have full back up and maintenance is based on failure.

5.10.4. ASSET ISSUES AND RISKS

No new issues or risks have been identified for the SCADA system.

5.10.5. ASSET REPLACEMENT

Communication and control assets are replaced as part of the overall system development to ensure compatibility.

5.11. METERING SYSTEMS

VECTOR's bulk metering systems consists of a number of intelligent web-enabled revenue class energy and power quality meters communicating within the metering central server over an Ethernet based IP routed communication network.

The system provides VECTOR with essential information to control cost, quality and reliability of the power delivered to VECTOR's customers. It is currently used to:

- Improve operational efficiency by controlling peak demands at the grid exit points, which ultimately reflects in reduced line charges to VECTOR's customers
- Provide comprehensive power quality and reliability information that will enable the verification of quality of power delivered to our customers against the published VECTOR service levels, and faster resolutions of power quality issues
- Increase the power supply stability by initiating instantaneous load shedding during grid under frequency events

5.12. 11KV AND 400V OVERHEAD NETWORK

5.12.1. ASSET DESCRIPTION

The overhead system consists of over 4,500km of 11kV line and over 5,300km of 400V line. Over 155,000 poles support the overhead distribution network, of which 22% are wooden and 78% concrete. Conductors vary across the overhead network, but are predominantly Cu and AAC. AAAC has been trialed and is considered for use on any major line construction. ABC and CCT are used in areas susceptible to tree damage, where the trees cannot be cut or removed due to resource consent and council restrictions.

5.12.2. ASSET CONDITION AND PERFORMANCE

__Improvements for Reliability: Auckland Network__

Overhead Service Fuses

230V service fuses remain one of the highest failing asset groups in the network, with associated high remedial costs, although failure rates are low in terms of the total asset population.

All new service fuse or replacement fuse holders use IPC technology for connections and contain HRC fuses. Re-wireable fuses are no longer installed on the network and have been removed from the approved equipment standards.

We have evaluated the cost benefit of mass replacement of pole fuses in areas which have high failure rates and remedial costs. No patterns have emerged as failures appear to be spread across the network so there is not justification for mass replacement. All service fuses are replaced when the associated crossarm is replaced.

Fault Passage Indicators

Stage two of the programme to install overhead Fault Passage Indicators (FPI) in areas of the network where fault location is difficult and time consuming is complete. To date, FPI's have been installed at 177 locations giving us the capability to detect phase to phase and phase to earth faults, leading to faster restoration and more effective fault analysis.

Small Scale Overhead Improvements

In a number of sites, poles and overhead lines have been replaced with underground cables to improve reliability in areas where there was frequent and repeated damage to the overhead network by vehicle impacts. Car versus pole incidents continue to be one of the leading fault causes in the Auckland network. Considerable analytical effort has gone into identifying trouble spots, and we are working closely with the Land Transport and Safety Authority and the Councils to identify and implement the most cost-effective mitigation measures. In some cases these involve traffic engineering solutions.

HV Connectors Replacement

The programme to replace HV feeder connectors with fault rated connectors has already proven to be successful, with a significant drop in secondary faults through jumper burn-offs. The replacement programme will continue through 2003/04.

Overhead Switches

On the Auckland network, existing air break switches (ABS) which meet the criteria for replacement are being replaced with fully enclosed gas insulated (SF_6) switches which have minimal maintenance requirements, extended life, enhanced reliability and safer operation.

Approximately 50 units have been installed to date.

Ultrasonic pole testing

VECTOR has continued with ultrasonic testing of wooden poles. The ultrasonic methodology gives an accurate, consistent assessment of pole condition that is not influenced by the operator's opinion. The condition of the pole can be easily determined and decisions made on appropriate maintenance and replacement activities. Ultrasonic testing and subsequent serviceability indices analysis is now part of the standard preventative maintenance work. All wooden poles supporting transformers of 100kVA or greater were tested in 2002/03, and to date approximately 70% of the wood pole population has been assessed using this method. The remainder will be completed by 2005. By the end of 2005 it is expected that the remaining life of all wood poles will be reasonably predictable. Ultrasonic pole testing has been introduced and is underway in the Northern and Wellington networks.

Transformer neutral connectors

A programme to replace all transformer neutral connectors was completed in 2001/02. A subsequent programme to replace all main line neutral connectors is in progress and on target for completion in March 2004. A study is running through this year to determine if there is a need to replace all service main neutral connectors. This programme was initiated to avoid the risk of customers being affected by return currents via house earths.

Use of this GIS analysis capability is also made by VECTOR and its service providers to identify key trends across our asset base. As our fault data is linked to fault cause in addition to assets, we are able to get a very clear overview as to what type of assets fail and when, lifting both our analysis and response ability to a higher level. Figure 5.5 shows an example of this type of data for neutral connections.

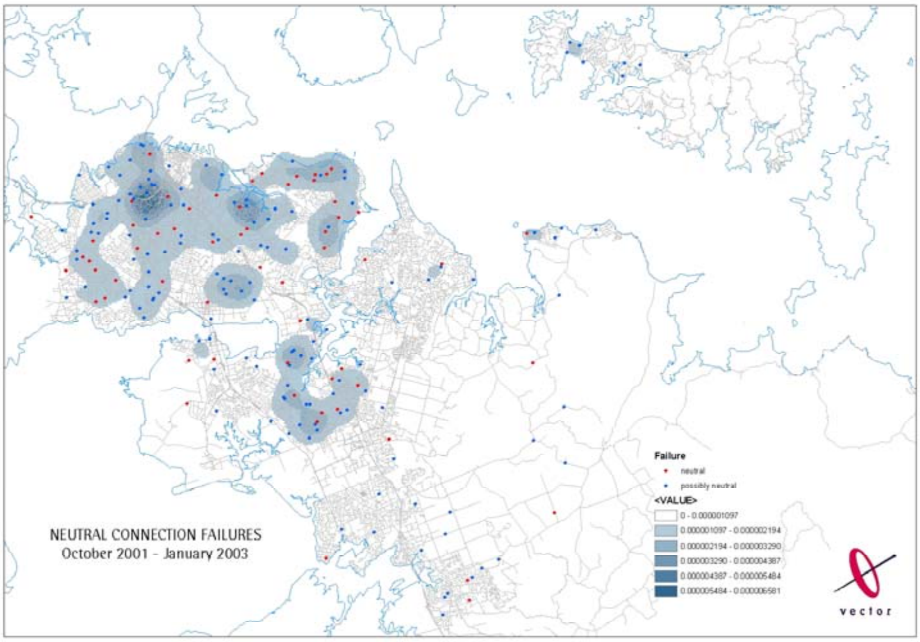


Figure 5.5 Neutral Connection Failures

Improvements for Reliability: Northern and Wellington Networks

Harbour Crossings

For marine crossings, lines have been marked with indicator reflector flags to avoid the risk of low flying aircraft. Conventional indicator balls could not be used because the wind loading on the balls was calculated as excessive for the conductor.

Conductor Sleeving

A number of overhead 11kV spans which were identified as experiencing conductor clashing have been fitted with sleeves. The sleeves are designed to prevent transient occurrences from resulting in a feeder tripping.

Automatic Reclosers

A programme has been initiated to replace reclosers to assist with the discrimination of overhead faults and the minimisation of affected customers. The latest technology vacuum type reclosers provide an enhanced level of measurement, protection and reliability and will continue to be installed where appropriate to improve service.

5.12.3. MAINTENANCE

- Annual visual line patrol of poles and hardware, including clearance checking to meet the Electrical Code of Practice
- Five yearly condition assessment of wooden poles using ultrasonic methodology
- Five yearly detailed inspection of all poles and hardware
- Proactive vegetation management and local council vegetation management agreements
- Three yearly inspection of earthing connections
- Five yearly measurement of earth sites
- Three yearly ABS inspection and operation

5.12.4. ASSET ISSUES AND RISKS

The following issues for the 11kV and 400V overhead assets, their current controls, and required actions are detailed in Table 5.2.

Issue Description	Issue Impact	Current Controls	Action
Failure of the No 1 PSC pole when work is being carried out	Health and Safety	Service providers advised of the possible risk	Auckland University has completed destructive tests on a sample of No. 1 PSC poles No pole has failed below the designed ultimate strength of the pole
Identification of stay wires are not in compliance with ECP 34:2001	Health and Safety		Survey focussing initially on sensitive areas. Any non-compliant assets will be rectified through the use of stay insulators, PVC sleeving and conspicuous marking
Failure of service fuse assembles	Reliability through premature failure through overheating of the connection to the jumper	Service providers advised of the possible risk	Targeted replacement programme

Table 5.2 Overhead Distribution: Asset Issues and Risks

5.12.5. ASSET REPLACEMENT

Poles

With the introduction of ultrasonic testing with the Auckland network, VECTOR has developed pole replacement criteria which exceeds the requirements of SREI, Appendix G. Any poles that when assessed have a remaining strength of less than 50% of original strength are subject to an engineering analysis to determine their serviceability index as defined in HbC(b)1-1999 and AS/NZ4676 (2000). Poles with an unacceptable serviceability index are tagged for replacement, and poles with a marginal serviceability index are scheduled for re-test. This approach will be replicated within the Northern and Wellington networks.

It is VECTOR's policy to view areas with high volumes of yellow tag poles as candidate areas for wider scale asset replacement.

A major focus for 2003/04 will be strengths of termination poles and investigation of pole life extension techniques.

Cross Arms and Hardware

Cross arms are visually inspected and replaced as required.

Pole cross arms and hardware are replaced to meet the current equipment standards when a pole is replaced, and as individual items when condition indicates this is the best option.

Lines

The lines are inspected on an annual basis and replacement is based on condition assessments and analysis of fault history. Some localised re-conductoring is planned in 2003/04 to replace the existing line with CCT or ABC in areas where tree damage is frequent and there are restrictions on tree cutting. A continuing focus for 2003/04 will be on re-tensioning conductors in low clearance spans.

Air Break Switches (ABS)

ABS are replaced based on a set of performance criteria. ABS will be replaced with SF_6 switches when required.

5.13. 11KV AND 400V UNDERGROUND DISTRIBUTION NETWORK

5.13.1. ASSET DESCRIPTION

The underground distribution network consists of over 3,900km of HV cable and over 6,100km of LV cable. HV cable types are predominantly PILC, with XPLE now standard for new cables. LV cables are predominantly PILC and PVC insulated cables.

5.13.2. ASSET CONDITION

Improvements for Safety: Auckland Network

Pillar Internal Inspections
Loose connections in the line or neutral within pillars have the potential to cause shocks and power outages. To mitigate this risk VECTOR is continuing a programme of internal pillar inspections, which includes checking connections, looking for heat damage, earth loop impedance tests and security. The earth loop impedance test also assists with checking the condition of connections between the customers point of supply and the distribution substation. This test procedure has proved very successful and we will review the benefits of replicating it in the Northern and Wellington networks.

Service Fuses

To remove the risk of connection failure which could lead to possible damage to the customers property, the programme to replace wall mounted service fuses was initiated in 2001/02. Approximately 32,000 premises have been checked to date, with 27,000 fuses being replaced with fully insulated fuses and IPC connectors. The remaining 1,700 premises will be checked this year.

Improvements for Safety: Northern and Wellington Networks

Frank Wild 11kV Termination Box Replacement

A small number of above ground 11kV junction boxes remain in the Northern network. A termination failure occurred in 2002/03 which was attributed to the high humidity environment and poor ventilation of the cubicle. The remaining termination boxes have been inspected and new ventilated covers are currently being fitted.

Cast Iron Cable Terminations

The replacement of cast iron 11kV cable terminations has continued. Investigations have revealed evidence of water absorption, resulting in termination failure. The targeted replacement has resulted in a significant reduction in failures.

5.13.3. MAINTENANCE

- Maintenance for both 11kV and 400V cables is reactive, based on faults
- Two yearly visual inspection of pillars, plus pillar internal checks and loop impedance testing (in the Auckland network)

5.13.4. ASSET ISSUES AND RISKS

The following issues, their current controls and required actions have been identified for the 11kV and 400V underground assets and are detailed in Table 5.3.

Issue Description	Issue Impact	Current Controls	Action
Third party damage through digging and thrust boring	Reliability Health and Safety	Free cable location service and obstruction plans for service providers and the public DialB4Udig campaign launched in 2000	OSH and VECTOR working proactively with service providers to ensure correct process for cable location is followed
Failure of fault passage indicators due to age and environmental condition	Reliability	Current review of the electrical/mechanical type of fault passage indicator to determine what factor/s are impacting on their operation. Old units are being dismantled to identify causes of false indication. The output of the review will be a recommendation for repair or replacement	Replacement of approximately 300 failed units planned for 2003/04 in the Auckland network
Corrosion of LV Under Veranda boxes from prolonged exposure to the elements	Reliability Health and Safety	Service providers advised of the possible risk	Replacement programme underway in the Wellington network

Table 5.3 Underground Distribution: Asset Issues and Risks

5.13.5. ASSET REPLACEMENT

Cable Terminations

The inspection programme for cable terminations is limited to a visual check for compound leaks. Acoustics and thermographics have been trialed as an alternative condition assessment methodology, but results remain insufficiently reliable to be useful. Replacement is therefore driven by the visual inspections and analysis of fault rates. The impact of the replacement work within all networks is being carefully monitored to assess the benefits of asset replacement compared to run to failure for this asset group.

Cables

Cable replacement is based on a combination of fault rate analysis and the tests performed following fault repairs. It is proposed to progressively replace the relatively small amount of remaining 11kV aluminium sheath cable in the Auckland network over the next five years due to corrosion of the sheath leading to reliability problems. The majority of this cable type has already been replaced and this proposed work will complete the asset replacement.

__Fault Passage Indicators__

Individual asset replacement based on failure.

__Pillars__

Pillars are replaced based on fault, normally through foreign interference. Each damaged pillar is assessed to determine the risk of future potential damage by vehicles due to location. If the risk is high the pillar is replaced with a pit.

5.14. DISTRIBUTION TRANSFORMERS

5.14.1. ASSET DESCRIPTION

VECTOR owns and operates over 23,000 distribution transformers of which 61% are ground mounted and 39% are pole mounted. The ground mounted transformers are either stand alone, enclosed in metal or fibreglass canopies, open enclosures or fully enclosed within other buildings. The transformers are generally rated between 30 and 1,000kVA, although there are a small number rated at 1.5kVA, 5kVA, 7.5kVA and 10kVA. Figure 5.6 shows the age profile of the distribution transformer assets.

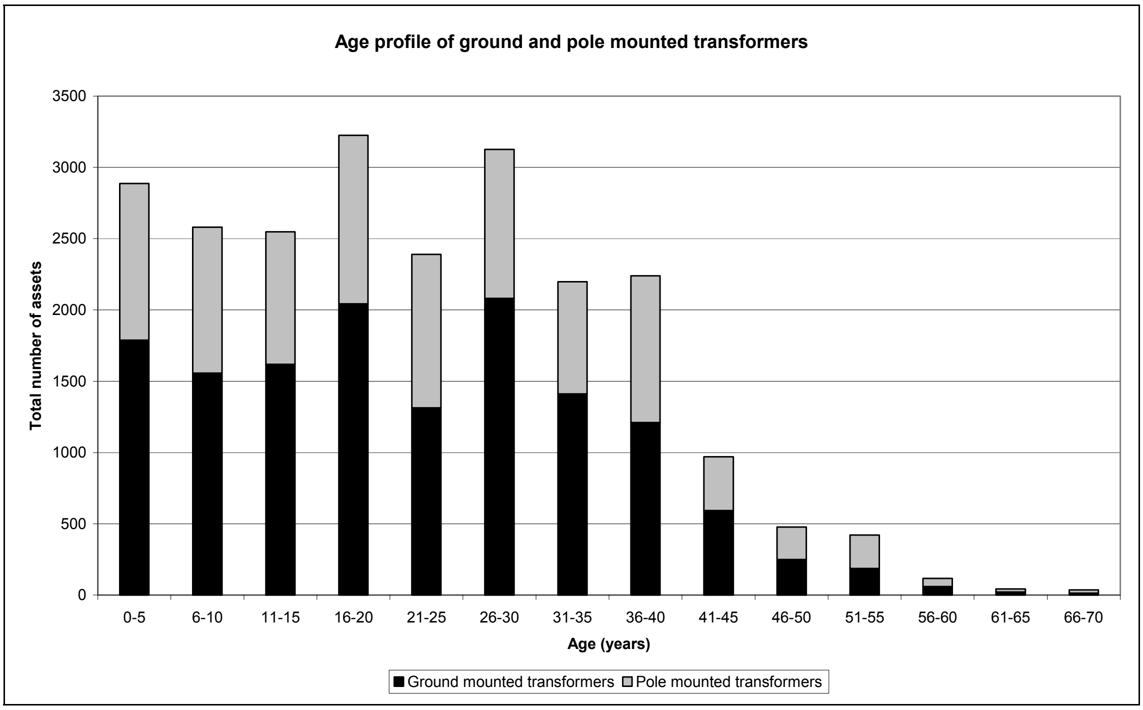


Figure 5.6 Distribution Transformers Age Profile

5.14.2. ASSET CONDITION

The condition of the transformer asset is generally good. However, inspections of recent transformer installations has identified that a number of the transformers are exhibiting signs of rusting. Discussions are continuing with the transformer manufacturers to identify and eliminate the causes for the premature rusting, quantify the number of transformers affected and carry out remedial work.

Improvements for Reliability: Northern and Wellington Networks

Transformer Load Management Model
A sophisticated model has been developed to assess the loading behaviours of each transformer in the Northern area network area. The model considers a number of critical factors and enables precision targeting and replacement of shared transformers.

5.14.3. MAINTENANCE

- Visual transformer inspection on a three year cycle
- Load records on a three year cycle
- Earthing resistance tests on a three year cycle, including MEN resistance, individual bank resistance and step and touch potential

5.14.4. ASSET ISSUES AND RISKS

No new asset issues or risks have been identified for the distribution transformer assets.

5.14.5. ASSET REPLACEMENT

Transformers are replaced if they do not meet specified criteria or on an as failed basis. Transformers that are identified during inspections as requiring replacement due to age or condition will be replaced in 2003/04. All failed transformers are returned to the VECTOR facility management contractor for investigation of failure and a decision is made on the cost benefits of repair, refurbishment, replacement or scrapping of the asset. As part of VECTOR's continual improvement process the use of other types of transformers and cooling and insulating mediums is being investigated. Use of equipment without oil would eliminate damage to the environment caused by oil spills and leaks.

5.15. DISTRIBUTION SWITCHGEAR

5.15.1. ASSET DESCRIPTION

Ground mounted switchgear is a mix of oil, SF_6 and resin insulated equipment and is of varying ages and manufacturers.

5.15.2. ASSET CONDITION

The condition of the switchgear asset is generally good. However, incidents involving switchgear during 2002/03 has highlighted one issue. This concerns the rusting and subsequent failure of busbar band joints on Long and Crawford switchgear in open enclosure distribution substations within the Auckland network. VECTOR's service providers will be prioritising their inspections of switchgear of this manufacture in their three yearly switchgear inspections as part of their Preventative Maintenance plans. Busbar band joints will be replaced as required. We will be reviewing this switchgear in the Northern and Wellington networks to evaluate if there are similar issues.

5.15.3. MAINTENANCE

- Visual inspection on a three year cycle
- Full service on an eight year cycle

5.15.4. ASSET ISSUES AND RISKS

The following issues, their current controls and required actions have been identified for the underground distribution assets and are detailed in Table 5.4.

Issue Description	Issue Impact	Current Controls	Action
ABB SD switchgear fuse switches failing to trip despite operation of a HV fuse link and striker pin after a fault. It was also found that it was possible for the fuse strikers pin to break off when the fuse link was being removed and contact live terminals, thus causing an explosion and possible injury to the switch operator. The problem was identified as use of an incompatible type of HV fuse links (SIBA) in that type of switchgear	Reliability Health and Safety	Service providers advised of problem and operating instructions changed	Service providers to not purchase or install SIBA fuses
Industry concerns over safety while operating SD HV switchgear	Health and Safety	Service providers advised of problem and operating restrictions put in place	Planned replacement programme of critical assets under review

Table 5.4 Underground Distribution: Asset Issues and Risks

5.15.5. ASSET REPLACEMENT

Switchgear replacement is based on condition and availability of components for repair. Any failed switchgear units are returned to the VECTOR facility management contractor for investigation of failure and a decision is made on the cost benefits of repair, refurbishment, replacement or scrapping of the asset. As part of VECTOR's continual improvement process the use of oil filled switchgear was reviewed and other types of switchgear investigated. Use of equipment without oil will eliminate damage to the environment caused by oil spills and leaks.

As a result of this review the purchase and installation of SF_6 distribution switchgear for the Papatoetoe and Rosebank Overhead Improvement Programmes was recommended on a trial basis. Installation of the switchgear is proceeding at Papatoetoe. The switchgear installations in both areas will be assessed and monitored over the 2003/04 year.

5.16. DISTRIBUTION SUBSTATIONS

5.16.1. ASSET DESCRIPTION

VECTOR owns and operates over 23,000 distribution substations. The substations are maintained with regard to security, condition and safety.

5.16.2. ASSET CONDITION

The condition of the substations is generally good.

Distribution substations and enclosures are visually inspected and maintained annually. The types of defects and observations noted in the first two years of inspection were consistent across the network and were generally relatively minor in nature. Equipment in enclosed substations is generally in good condition, with minor oil or cable compound leaks being the main items to be addressed. Equipment in outdoor substations is in similar condition to that in enclosed substations except that it has a higher corrosion rate and there is an issue with rusting switchgear busbar band joints. Substation enclosures are also generally in good condition. The main issues found were with vegetation, access problems, and security of the substation.

5.16.3. MAINTENANCE

Visual checks and maintenance are carried out annually. Checks and maintenance include access, security, signage, graffiti removal, vegetation management, cleaning and weatherproofing etc.

5.16.4. ASSET ISSUES AND RISKS

No new asset risks or issues have been identified.

5.16.5. ASSET REPLACEMENT

Distribution substation enclosure and equipment replacement is on an as failed basis.

5.17. FORECAST MAINTENANCE EXPENDITURE

Table 5.5 shows forecast operational maintenance expenditure over the planning period.

	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13
Maintenance expenditure	31	29	27	26	25	25	25	24	24	24

Table 5.5 Forecast Maintenance Expenditure ($ million)

6. RISK MANAGEMENT

Asset risk in VECTOR is an integral part of the asset management process. Asset risks, the consequences of failure, current controls to manage this, and required actions are all understood and evaluated as part of the asset function and performance analysis. Any risks associated with the assets or operation of the network are evaluated, prioritised and dealt with as part of the asset maintenance, refurbishment and replacement programmes. The acceptable level of risk will differ depending upon the level of risk our customers are willing to accept and the circumstances and the environment in which the risk will occur. As part of the risk analysis, very low probability events with high impact are analysed, such as total loss of a zone substation. From this analysis contingency plans are developed. Risk is managed in VECTOR by a combination of:

- Reducing the probability of the failure, through the capital and maintenance work programme and enhanced working practices

- Reducing the impact of failure, through contingency and emergency plan development

The capital and maintenance asset risk management strategies are outlined in the Asset Maintenance and Development sections. VECTOR's contingency and emergency planning is based around procedures for restoring power in the event of a fault occurring on the network, and are detailed in Section 6.5.

6.1. RISK ACCOUNTABILITY AND AUTHORITY

6.1.1. VECTOR BOARD

The Board endorses the risk context under which VECTOR operates. A Board Risk Committee meets regularly, reviewing the risk register and risk methodologies at least quarterly.

6.1.2. EXECUTIVE RISK MANAGEMENT COMMITTEE

The Executive Risk Management Committee oversees and monitors implementation of appropriate and consistent risk management in each business unit, and across the company as a whole, by:

- Developing and maintaining, for the Board's review and approval, a risk management policy for VECTOR consistent with the company's objectives
- Overseeing and monitoring the implementation of risk management across VECTOR to ensure that it is in compliance with the risk management policy

One of the requirements of the Charter of the Executive Risk Management Committee is:

"Secure a comprehensive third party audit of the application of risk management at VECTOR at least every two years, and a third party audit of key elements at least annually."

The aim of the audit is to consider:

- The extent to which VECTOR is applying its risk management structures, accountabilities, processes and reporting mechanisms in support of its risk management policy
- Opportunities for improving VECTOR's established risk management policy, structures, accountabilities, processes and reporting mechanisms in support of the company's business goals

The audit was carried out by Marsh Limited and confirmed that risk was being managed at VECTOR in accordance with accepted standards. The audit report also recommended several improvement opportunities which are currently being implemented, one of these being workshops with all members of staff to highlight risks and seek ideas.

6.1.3. RISK COMMITTEE

The Risk Committee is a small inter-functional team, which evaluates any identified risks in a consistent manner, assigns priorities and actions, and monitors progress. The Risk Committee meets regularly to:

- Assess all new risks identified, assign priority and actions to the risks and record them in the risk register
- Define accountabilities for the risk management programme
- Review priority and actions for entries on the active register
- Monitor progress on actions assigned against entries in the register
- Report on new high priority entries and progress on resolution of existing high priority entries
- Create a company risk profile

6.1.4. ALL EMPLOYEES

All staff and service providers are responsible for reporting any identified risks that come to their notice. Each functional area within VECTOR has a risk register on which risks, solutions and accountabilities are listed. Some of these risks are dealt with at an operational level and others have their profile raised and become part of the overall VECTOR risk register for action.

6.2. RISK MANAGEMENT PROCESS

The risk management process for VECTOR is now in the process of evolving to one of focusing on and analysing critical and catastrophic type events. The output of this is an understanding of the consequences of failure from critical and catastrophic events, valuing the impact of the event and defining response plans. (Ordinary risks, the consequences of which can be relatively easily "absorbed" by VECTOR or the customer are managed in the normal line of business).

The risk management process adopted by VECTOR is shown in Figure 6.1.

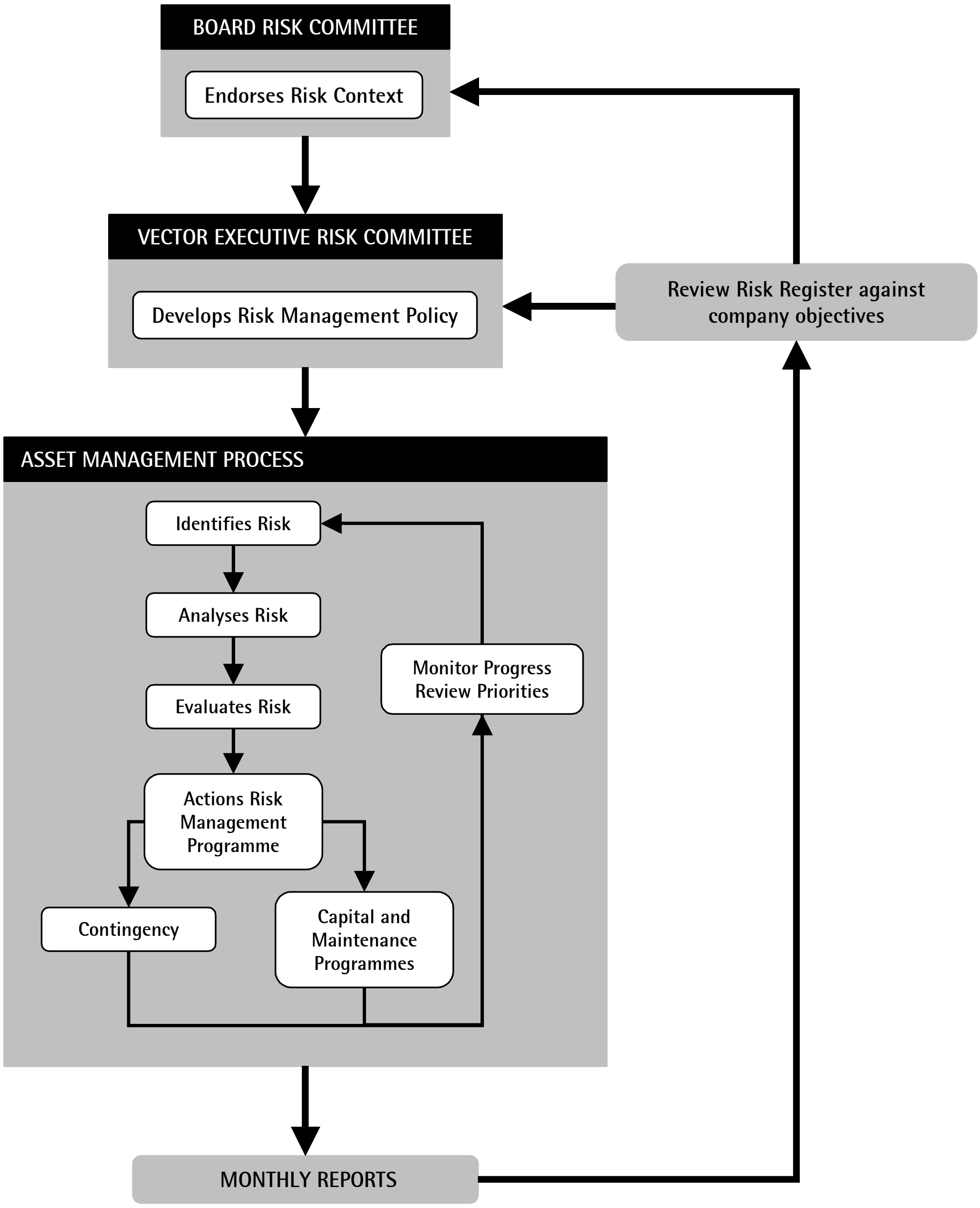


Figure 6.1 VECTOR's Risk Management Process

VECTOR's risk management policy is defined to ensure that:

- All risks to the business are identified and understood and works prioritised to mitigate risk with a top 20 risk register being maintained and tracked at Board level
- Practices that could cause disruption to service and operations, injury to people or the environment, or significant financial loss are understood, documented and mitigated
- The business is protected by suitable insurance polices, or contingency plans, wherever necessary

6.3. <u>RISK IDENTIFICATION AND ANALYSIS</u>

All risks are assigned a risk level based on the likelihood and consequence of the risk. Risk is determined using VECTOR's risk prioritisation matrix, shown in Figure 6.2.

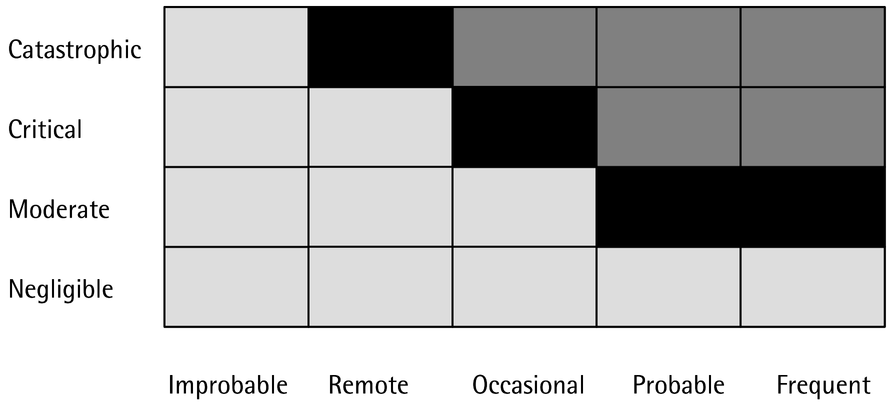


Figure 6.2 VECTOR's Risk Prioritisation Matrix

Catastrophic risk includes loss of life, extended loss of supply, or financial loss of a magnitude sufficient to impact on the company.

HIGH: These risks require immediate review and continuous monitoring to ensure the "due care" test is met. If measures cannot be implemented to control the risk, actions are required to reduce the inherent nature of the risk.

MODERATE: These risks require less rigorous ongoing control, but require continuous monitoring to ensure they do not become a high risk.

LOW: These risks require tracking on a periodic basis, to ensure they remain a low risk.

All catastrophic risks are assessed in terms of contingency planning, irrespective of their probability.

6.4. RISK MANAGEMENT PROGRAMME

VECTOR maintains a risk register, which is formally updated on a monthly basis for presentation to the Executive Risk Management Committee, and quarterly to the Board Risk Committee. The risk register documents the top 20 risks to the business and their response plans.

6.5. CONTINGENCY PLANS

6.5.1. SWITCHING

For all major feeders, the network is designed to allow reconfiguration by switching so that power can be fed through an alternative path if there is a failure or a need to shift load. For the CBD, this switching is carried out remotely through the SCADA system.

In the event of failure of a minor feeder, Control Room operators undertake network analysis and instruct field crews to undertake manual switching to restore power to as many customers as possible (while the fault is repaired), especially to critical customers.

6.5.2. CRITICAL SPARES

A stock of spares is maintained for critical components of the network so that fault repair is not hindered by the lack of availability of required parts. Whenever construction of a new part of the network is undertaken, an evaluation is made of the spares that will be retained to support repair of any key equipment installed.

6.5.3. DISASTER ANALYSIS

Plans are developed, as part of the overall management of the network, which consider the actions that would be taken in the event of a major failure of part of the network. Such plans consider switching options and the rapid construction of temporary lines.

If there is specific concern regarding a risk to the network, detailed contingency plans are developed, which include detailed design of the required temporary lines and the securing of materials required to allow immediate construction.

6.5.4. CIVIL DEFENCE AND EMERGENCY MANAGEMENT ACT

VECTOR is required under the Civil Defence and Emergency Management Act 2002 (CDEM) to be "able to function to the fullest possible extent, event though this may be at a reduced level, during and after an emergency" and also to have plans for functioning during and after an emergency.

A business continuity plan for VECTOR has been developed and is current being finalised. VECTOR is also a member of the Auckland Engineering Lifelines Group (AELG) and through this membership keeps abreast of development in the CDEM area to ensure it is fully prepared for an emergency.

6.5.5. HEALTH AND SAFETY

At VECTOR safety is a value, not merely a priority. The VECTOR safety culture described below is being adopted in the broader organisation following the acquisition of UNL.

VECTOR's policy is to:

> *"Create and maintain a safe and injury free work environment for our employees, our service providers, our suppliers and the public we serve."*

To support the VECTOR safety policy a set of Safety Guiding Principles have been adopted by the company and our service providers. They reflect the principles of other world-class companies, and define the ultimate responsibility of management to lead and implement the safety process, while at the same time recognising each individual's responsibility to work safely.

- Everyone is responsible for safety
- We look out for each other
- Safety will be planned into our work
- All injuries are preventable
- Management is accountable for preventing injuries
- Employees must be trained to work safely

VECTOR's Safe Work Practices define the essentials necessary to maintain an injury free environment. These practices reflect the basic approach necessary for VECTOR and our service providers to identify and eliminate accident causes.

All service providers working for the company are required, as a minimum, to comply with these Safe Work Practices whilst carrying out any work on the network. Service providers are also required to report all employee accidents/incidents and near misses to VECTOR together with their relevant investigations and intended corrective actions. The service providers are incentivised through the contract bonus structure to achieve the VECTOR safety targets.

As part of our focus to continually improve health and safety, we have employee safe teams and a Safety Leadership Team – a task force which encourages all staff to voice their opinion on company safety standards, raise concerns and suggest improvements.

In conjunction with Duke Energy we have undertaken a number of audits of our health and safety systems and processes. The latest audit classed us overall as good, and that we had made significant progress in a number of areas. There is no scope to relax and we will be looking for further significant improvements in health and safety.

Our progress on health and safety is shown in Figures 6.3 and 6.4.

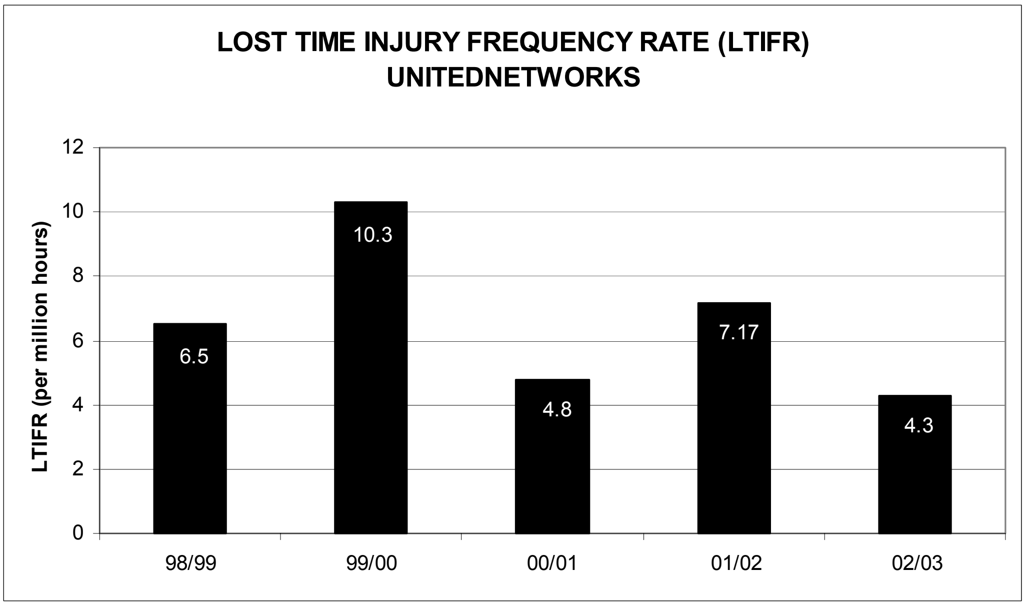


Figure 6.3 Network Safety Performance (UnitedNetworks and Service Providers)

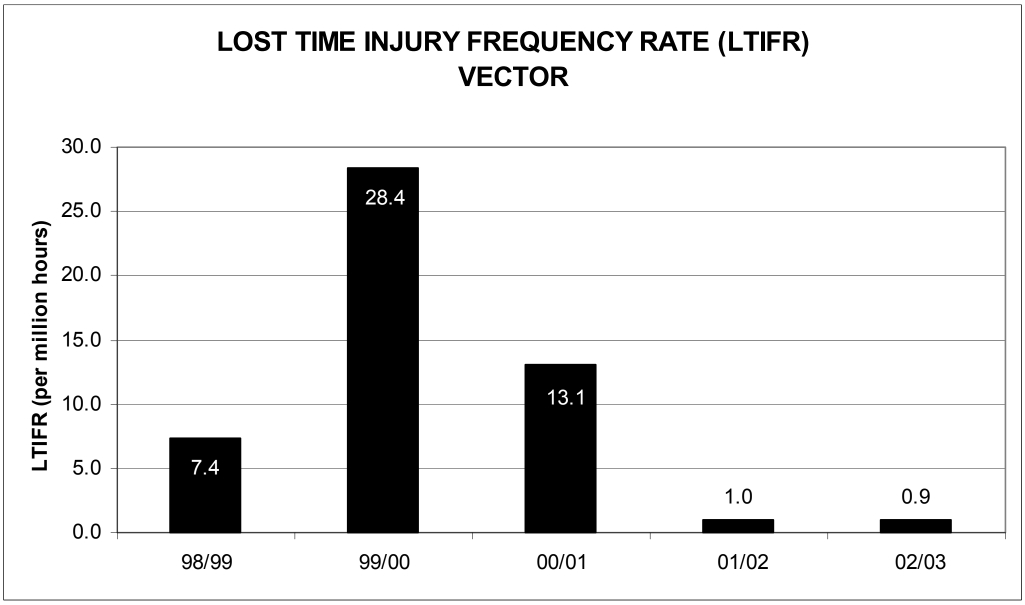


Figure 6.4 Network Safety Performance (VECTOR and Service Providers)

Our ongoing safety target is simply:

"No lost time injuries to any person working on our network."

7. EVALUATION OF PERFORMANCE

7.1. PROGRESS AGAINST PLANS

7.1.1. CAPITAL PROJECTS IN THE AUCKLAND NETWORK

The 2002/03 capex plan included a total of $19m for new capital projects expected to be approved in the 2002/03 year. The total value of new network capital projects actually approved (excluding customer initiated projects) was $15m. The significant variances were due to:

- Deferment of asset replacement projects based on enhanced or new conditional information indicating that assets were achieving the required functionality at low or acceptable risk.
- Removal of projects when detailed analysis proved the expected performance improvements and/or cost savings would not be realised.
- Timing issues.

7.1.2. CAPITAL PROJECTS IN THE NORTHERN AND WELLINGTON NETWORKS

The 2002 capex plan included a total of $46m for new capital projects expected to be approved in the 2002 year. The total value of new network capital projects actually approved (excluding customer initiated projects) was $43m. The significant variances were the result of:

- The deferral of a number of overhead distribution asset replacement projects (poles, crossarms, connectors, re-conductoring etc) in the Wellington Region due to the introduction of ultrasonic pole testing and subsequent re-classifications.

- The deferral of some zone substation upgrade projects (seismic, oil retention, fire protection, batteries etc.) in both Northern and Wellington networks, due to the work requiring further investigation and definition. It is expected that this work will be undertaken in 2003.

- The deferral of a number of replacement related projects due to changing third party circumstances. An example being those related to the construction of the busway on Auckland's Northern Motorway.

- The deferral of information system projects following the purchase of UNL by VECTOR.

7.2. PERFORMANCE AGAINST TARGETS

VECTOR has in place detailed performance targets that are defined and linked to ensure that we are striving for and achieving the company goals in an optimum and efficient way.

Physical performance in VECTOR is tracked through:

- Reliability
- Safety
- Customer satisfaction

These measures:

- Are directly applicable to the core business
- Support the aims of the strategic business
- Enable VECTOR to track and easily communicate performance
- Enable direct comparison with other companies for the purposes of benchmarking

The ongoing results of these measures are communicated on a monthly basis to all VECTOR employees and service providers. Accountability for the performance targets is a function of all employees. The service providers are incentivised through the contract bonus structure to achieve their targets and VECTOR direct employees have the physical performance measure embedded in the performance related pay scheme.

7.2.1. RELIABILITY

The time weighted reliability targets and actuals for the combined network for 2002/03 are shown in Table 7.1.

	2002/03 Target	2002/03 Actual
SAIDI	56.1	87.4
SAIFI	1.0	1.4
CAIDI	53.7	62.9

Table 7.1 Reliability Statistics (inclusive of Transpower outages)

The targets set for 2002/03 were stretch targets designed to push the assets and service providers who are incentivised to achieve the reliability targets. Whilst we did not achieve the SAIDI target we set ourselves, good progress is being made in reducing the fault numbers in areas we have direct control over. We continue to work proactively with Transpower to improve customer focus and reduce the outages due to Transpower faults.

We are proactively targeting the worst performing feeders, identifying the problem areas and initiating works to bring performance in line with our customer service levels.

Our service providers within the Auckland network are constantly reviewing the way they work in the field to minimise the impact of CAIDI. Where possible power is restored first and permanent repairs are progressed later, including the use of live line techniques to avoid further disruption to service. In addition, this approach to planned maintenance is different in the Northern and Wellington networks and we will be reviewing the risks, benefits and capability of the networks to enable increased live works.

7.2.2. SAFETY

Both VECTOR and UNL set safety targets around lost time injury frequency per million man hours worked. Both companies includes in these statistics all lost time injuries sustained by their employees and employees of their service providers whilst working on the network.

The target set for the year ending March 2003 was quite simply:

Zero lost time injuries

Performance at 31 March 2003 year end was:

- One lost time injury during the period at VECTOR
- Four lost time injuries at UNL

- A resultant lost time injury frequency of 0.9 for VECTOR and 4.3 for UNL

7.2.3. CUSTOMER SATISFACTION

VECTOR sets a customer satisfaction target based on a six monthly customer survey in the Auckland network. The survey measures customer satisfaction on an overall basis and is also broken down by key service points such as the call centre, the serviceman, and key account managers. The serviceman scores can be then further broken down to give an understanding of how service providers are performing and areas for improvement.

The targets are used to drive improvement in customer service and the results are communicated to all VECTOR staff and service providers. The targets are part of the performance bonus for staff and service providers. Current satisfaction actuals and targets are shown in Table 7.2.

1999/00 Actual	2000/01 Target	2000/01 Actual	2001/02 Actual	2002/03 Actual
74/100	79/100	77/100	79/100	83/100

Table 7.2 Customer Satisfaction Score

The target for 2002/03 for the Auckland network was set at 81/100 and was recognised as a considerable stretch from the previous year. The score achieved was 83/100 overall. An increase of four points should be recognised as a significant achievement, given that organisations at this level are considered to be high performers and gains become increasingly difficult to achieve.

Our focus on communication and increased awareness of the needs of the commercial customer helped drive our improvement. Targets for 2003/04 are yet to be developed but will no doubt be set at an increased level to encourage continuous improvement in this area.

Customer satisfaction within the Northern and Wellington networks is not currently measured in a similar direct way due to the interpose agreement structure.

7.3. PLANNED IMPROVEMENTS FOR PERFORMANCE

To improve performance and to ensure resources are targeted most appropriately, VECTOR has a number of planned improvements for 2003/04:

- Full integration of VECTOR and UNL, bringing together the best practices from each organisation

- Continued development of tools to enable VECTOR and the service providers to spot trends and improvement opportunities quickly and efficiently

- Continued implementation of smarter equipment in the field to enable more efficient fault finding and a focus on innovative field practices to substantially reduce outage times.