



Asset Management Plan

Protection and Control - Distribution

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Responsibilities

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- Implementation All TasNetworks staff and contractors.
- Compliance All group managers.

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Record of revisions

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Purpose

The purpose of this document is to describe for distribution protection, control and related assets:

- a) TasNetworks' approach to asset management, as reflected through its legislative and regulatory obligations and strategic plans;
- b) the key projects and programs underpinning its activities; and
- c) forecast CAPEX and OPEX, including the basis upon which these forecasts are derived.

1 Scope

This document covers protection and control assets within the distribution network. It does not cover the primary assets protected by the protection and control assets.

It does not cover the SCADA master station and communications medium to connect from the field equipment to the SCADA master station.

2 Strategic alignment and objectives

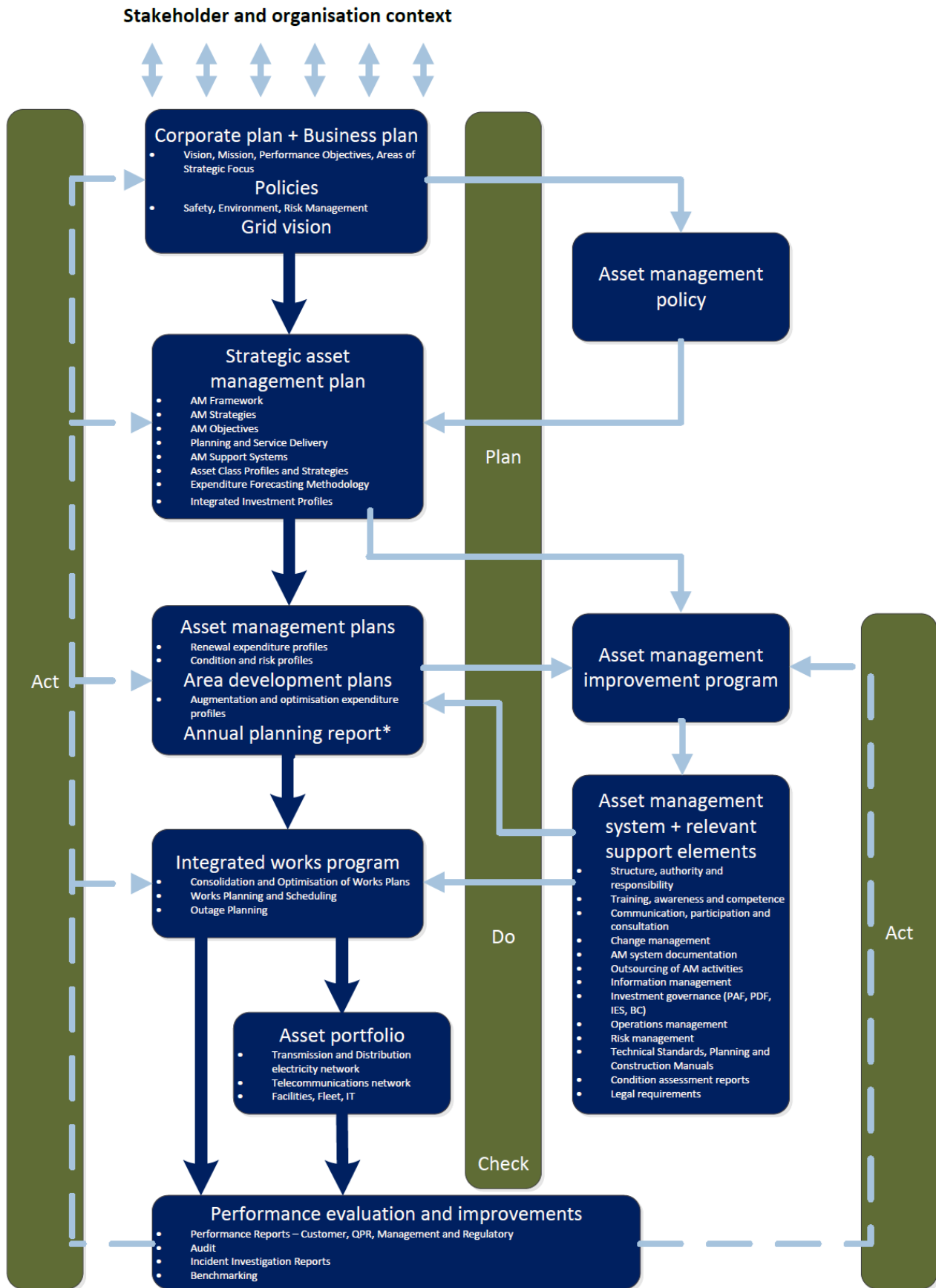
This asset management plan has been developed to align with both TasNetworks' Asset Management Policy and Strategic Objectives.

The asset management policy, contained within the Strategic Asset Management Plan, states 'Consistent with our vision and purpose, we strive for excellence in asset management and are committed to providing a safe working environment, value for our customers, sustainable shareholder outcomes, care for our assets and the environment, safe and reliable network services, whilst effectively and efficiently managing our assets throughout their life-cycle'.

It is part of a suite of documentation that supports the achievement of TasNetworks strategic performance objectives and, in turn, its mission. The asset management plans identifies the issues and strategies relating to network system assets and detail the specific activities that need to be undertaken to address the identified issues.

Figure 1 represents TasNetworks documents that support the asset management framework. The diagram highlights the existence of, and interdependence between, the Plan, Do, Check, Act components of good asset management practice.

Figure 1: TasNetworks Asset Management Documentation Framework



The asset management objectives focus on six key areas:

- a) Zero Harm will continue to be our top priority and we will ensure that our safety performance continues to improve;
- b) cost performance will be improved through prioritisation and efficiency improvements that enable us provide predictable and lowest sustainable pricing to our customers;
- c) service performance will be maintained at current overall network service levels, whilst service to poorly performing reliability communities will be improved to meet regulatory requirements;
- d) customer engagement will be improved to ensure that we understand customer needs, and incorporate these into our decision making to maximise value to them;
- e) our program of work will be developed and delivered on time and within budget; and
- f) our asset management capability will be continually improved to support our cost and service performance, and efficiency improvements.

3 Asset support systems

3.1 Systems

TasNetworks has a number of asset support systems in place to ensure the distribution protection and control assets are managed proficiently. They are listed as follows:

- a) PSS SINCAL, a power system network modelling tool with a protection module for grading and coordination studies;
- b) Windows Switchgear Operating System 5 (WSOS5), a software package that facilitates the remote control and monitoring of Schneider Electric pole mounted auto reclosers and load break switches;
- c) Control and Management Software (CMS), a configuration, monitoring and control tool used for NOJA Power's Automatic Circuit Reclosers (ACR);
- d) DlgSILENT StationWare, a protection settings database and management system used to manage the control parameters and to store substation related information; and
- e) purpose-built configurable database tools such as WASP and WebMap LV to access secondary asset data such as communications settings and device information. These tools provide real time linkages to TasNetworks' Spatial Data Warehouse (SDW), where various secondary asset data is captured.

3.2 Asset information

Asset data information for the distribution protection, control and related assets has varying availability and quality limitations across the asset portfolio, as summarised in Table 1.

There are a number of initiatives underway such as various asset audits and asset information system reviews, which aim to increase TasNetworks' asset data capability. Some asset data such as zone substation protection relay age information has to be assumed based on the most recent modernisation project date.

The Protection and Control - Distribution Thread is working with Network Information Systems team to increase TasNetworks' secondary asset data capability. An example of this is the development of asset data capture information pertaining to overhead fault indicators, resulting from the associated work program. Another such example is a longer term project, TasNetworks Integrated Business Solution (TIBS), which aims to fully integrate and improve TasNetworks processes and systems in relation to asset planning, operation and lifecycle management.

Table 1: Secondary Asset Information Summary

Asset Type	Device	Information Availability	Information Quality
Overhead Assets	Fault indicators	Poor	Poor
	Controllers	Average	Average
Ground Mounted Distribution Substation Assets	Protection relays	Poor	Poor
	Battery systems	Poor	Poor
	Controllers	Average	Average
	Fault Indicators	Poor	Average
Zone Substation Assets	Protection relays	Poor	Poor
	Battery systems	Average	Average
	SCADA/control devices	Average	Average

4 Asset description

TasNetworks manages distribution protection and control assets pertaining to:

- a) 12 major zone substations (with another under construction);
- b) 26 sub-transmission feeders;
- c) 240 distribution feeders; and
- d) over 30,000 distribution substations.

The distribution protection and control asset class encompasses the secondary protection/control assets from the low voltage service fuse to:

- a) the 22 kV feeder breaker (excluding); and
- b) the 33 kV and 44 kV sub-transmission feeder breakers (excluding).

The protection systems generally comprise current differential, over-current, earth fault and sensitive earth fault protection schemes. The focus of managing protection and control assets is to ensure that faults are rapidly detected and cleared to minimise asset damage and to maximise reliability benefits.

Due to its extensive coverage across the state and being a major determinant of supply reliability there has been a focus on overhead network protection. The higher reliability of underground cabling has required a lesser reliability-based focus with an emphasis on fault detection and clearance design performance requirements.

The protection systems within zone substations have all been replaced or upgraded with modern electronic (numeric) relays. The overhead system uses multi-level protection comprising protection within substations, modern electronic reclosers, sectionalisers, and fuses. The coordination of this multi-level protection requires considerable management time to ensure adequate and accurate protection.

For many underground feeders there is only one level of HV protection located within zone and distribution substations that typically comprise current differential, over current, earth fault and sensitive earth fault protection schemes. The underground HV network protection includes legacy electro-mechanical relays as well as modern electronic relays. As the protection is unit-based, there is a lesser need for management time to co-ordinate with lower voltage level protection.

The programs under the Protection and Control (distribution) asset class pertain to asset maintenance and replacement activities to ensure they are always in good working order to protect the primary plan in event of a network fault. The drivers behind these programs are various and relate to:

- a) age;
- b) condition;
- c) in-service failure;
- d) new functionality requirements;
- e) replacement based on obsolescence/lack of product support; and
- f) network performance improvement.

Economic lives for TasNetworks assets are sourced from TasNetworks Regulated Asset Base. In the case of SCADA, network control and protection systems this equates to ten years.

4.1 Overhead assets

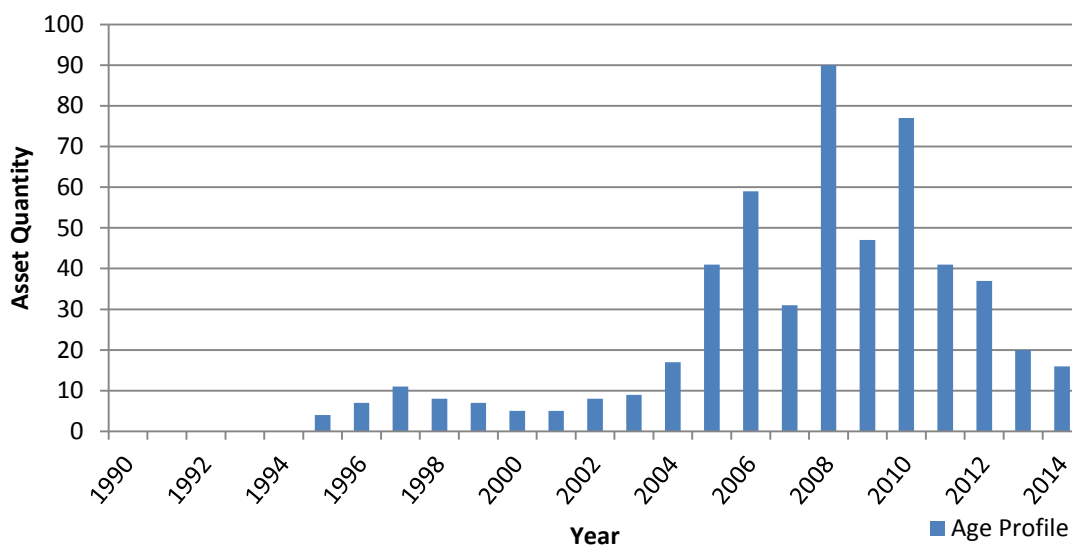
Overhead protection and control assets are listed in Table 2 below.

Table 2: Overhead asset volumes

Device	Description	Volume
Reclosers/ load break switch controllers	Schneider and Noja recloser/ load break switch controllers	529
Fault indicators	GridSense LT30 and LT40s and CHK RPU4s fault indicators	620
HV voltage regulator controllers	Eaton (Cooper) voltage regulator controllers	33
Total		1182

outlines that the majority of overhead assets with controllers (reclosers, LBSs and voltage regulators) were installed during the 2007-2012 regulatory period, and the level of activity pertains to the reliability strategies adopted at the time.

Figure 2: Overhead asset controller age profile, including reclosers, sectionalisers, LBSs and voltage regulators



TasNetworks recloser and LBS populations are almost entirely Schneider Electric (Nulec) devices, although TasNetworks has recently secured a supply contract with Noja Power for new devices in the future. Maintenance tasks for the associated controllers relate to proactive battery change-overs and the replacement of failed secondary components under fault. Over the next ten year planning horizon (DD17 regulatory period), TasNetworks plans to introduce proactive injection testing regimes to ensure the protection operates as designed.

TasNetworks’ fleet of overhead fault indicators include the CHK RPU3-S4 and the GridSense LT 30 of which there are 620. Overhead fault indicator asset data is relatively inaccurate in relation to age, but being of the proximity type, it is safe to assume that most were installed in the early to mid-1990s, meaning the average age is above 20 years. These devices are fitted with D-cell lead acid batteries and have maintenance program in place to replace them. Due to a large backlog in devices with dead batteries, this program was accelerated as part of a TasNetworks reliability incentive.

At the time of writing, the last remaining work program aimed at refurbishing fault indicator batteries is underway, which will facilitate a reduction in outage times and improve fault response capability. Upcoming work programs concerning overhead fault indicators include battery replacements and device replacements (proposed under the DD17 regulatory submission).

High voltage regulators do not have batteries to change out at regular maintenance intervals, but have regular inspection regimes as part of an associated primary asset work program (Substations and Underground Thread). As most of the Cooper regulators now have communications linkages, the SCADA watch-dog alarming provides notification of any device anomalies; which can be addressed either under fault, or as part of the routine maintenance.

4.2 Ground mounted distribution substation assets

TasNetworks’ population of ground-mounted substations is largely serviced by a network of underground distribution feeders. For many of these underground feeders there is only one level of HV protection located within zone and distribution substations that typically comprise differential schemes, over current, earth fault and sensitive earth fault detection schemes. The underground HV network protection includes legacy electro-mechanical relays as well as modern electronic

relays. As the protection is unit based schemes there is a lesser need for management time to coordinate with lower voltage level protection.

Ground mounted distribution substation protection and control assets are listed in Table 3 below.

Table 3: Ground mounted distribution substation asset volumes

Device	Description	Volume
Protection relays	Unit protection scheme and associated relays	445
Battery systems	DC systems for substations with unit protection	160
Control devices	Controllers for substation automation	13
Fault Indicators	Distribution substation controllers	474
Total		1092

Electro-mechanical protection relays in the ground-mounted substations include:

- a) Alstom MiDOS MHOB 04 relay;
- b) Alstom MiDOS MHOA 04 relay;
- c) Alstom MiDOS MHOA 02 relay;
- d) Alstom MBCI (Translay S) relay;
- e) Reyrolle B24 “send” relay; and
- f) Reyrolle B33 “receive” relay.

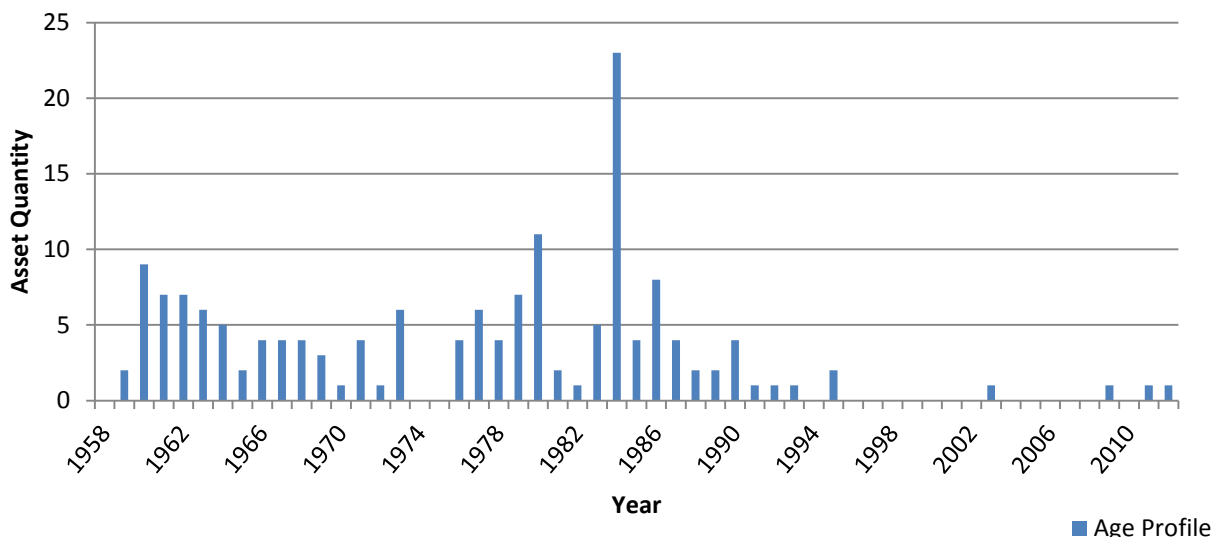
The exact numbers of the above relays are not known, but TasNetworks is undertaking exhaustive surveys to help remedy these limitations in asset visibility.

Ground mounted distribution substation battery system numbers relate directly to the substations with feeder differential protection schemes, referred to colloquially as “Translay”. These systems total 160 in number which TasNetworks has been actively replacing largely due to age. Replacement systems provide compliance with present day standards and facilitate remote monitoring capability via the pilot wire network which is the communications medium utilised by the protection.

A recent audit indicates TasNetworks has 87 Translay schemes across the distribution network.

Figure 3 outlines the age profile of the ground-mounted distribution substations according to installation date. In the absence of secondary asset age information, this is used as the basis for determining the age of the protection systems. There are 160 substations with Translay protection schemes.

Figure 3: Distribution substation age profile (in relation to protection)



TasNetworks also has a small population of 13 automation units which are installed in Schneider Electric pad-mount substations. The Easergy T200I automation units have recently been retrofitted and will be used by Network Operations as manual remote-controlled switching points on the network to assist in the restoration of supply. The devices are yet to be commissioned as Operational Standards personnel require further modification to switch automation circuitry for isolation and safety purposes. At the time of writing, a project is underway to install isolators on motor pack cables and to commission the SCADA.

Fault indicators are utilised in a significant portion of ground-mounted distribution substations although the exact number is not known due to data quality issues. Of the fleet of 2,200 substations, it is estimated that 22% have fault indication capability, in the form of local visual indication by way of clamped CT devices. After a fault has occurred, these devices activate a visual flag enabling operators on patrol to determine if the substation was on the fault path. These devices are all mechanical in nature, meaning that manual reset of the devices are required post-fault. As part of the upcoming regulatory submission (DD17), TasNetworks intends to proactively replace these devices with the modern equivalent, and some of these will be connected on the SCADA system.

4.3 Zone substations

Zone substation protection and control assets are listed in Table 4 below.

Table 4: Zone substation asset volumes

Device	Description	Volume
Protection relays/field devices	Unit protection scheme and associated relays	392
Battery systems	DC systems for substations with protection	12
SCADA devices	Zone substation SCADA devices	83
Total		487

TasNetworks’ zone substations serve as 33 kV and 44 kV injection points across the distribution network. There are 12 zone substations (at the time of writing Rosny Zone Substation is still under construction), with all but Trial Harbour Zone Substation located in the Greater Hobart area.

Zone substation discriminative protection schemes are designed to provide:

- a) co-ordination of protection, including with existing upstream and downstream protection;
- b) detection and clearing of system abnormalities in industry accepted time to minimise the impact on plant and public safety;
- c) selectivity such that the minimum amount of plant is removed or operated to limit its impact on downstream customers and retain firm capacity;
- d) be available to operate under all foreseeable system conditions;
- e) designed to allow the system to perform under normal operating conditions;
- f) compatibility with upstream protection devices and schemes;
- g) whole of life reliable and dependable service; and
- h) compliance to all regulatory code requirements.

Protection schemes at zone substations detect and clear the following types of faults from incoming sub-transmission feeders to the outgoing feeders at the zone substation:

- a) all phase to phase faults;
- b) all phase to earth faults;
- c) all power transformer faults at the zone substation;
- d) high impedance earth faults;
- e) all sub-transmission broken conductor faults;
- f) internal faults in the switchgear; and
- g) faults on the downstream distribution system in the event of a circuit breaker failure.

Whilst many of the zone substations were installed in the 1950s and 1960s, they have undergone significant modernisations over the past fifteen years. Due to limitations in asset data capability, the age of the protection equipment contained in these stations is associated with the most recent modernisation project as per Table 5 below.

Table 5: Zone substation age profile

Zone Substation	Voltages	Install Date	Date Modernised (protection)	DC Voltage
Geilston Bay	33/11 kV	1964	2001	32 V
Bellerive	33/11 kV	1971	2001	32 V
West Hobart	33/11 kV	1956	2002	125 V
Derwent Park	33/11 kV	1964	2003	32 V
New Town	33/11 kV	1966	2003	32 V
East Hobart	33/11 kV	1958	2004	125 V
Claremont	33/11 kV	1958	2006	125 V
Trial Harbour	44/22 kV	2007	2007	125 V
Cambridge	33/11 kV	2009	2009	125 V
Howrah	33/11 kV	2012	2012	125 V
Sandy Bay	33/11 kV	1967	2014	32 V
Summerleas	33/11 kV	2014	2014	125 V
Rosny (under construction)	33/11 kV	2015	2015	125 V

TasNetworks is moving to standardise on the protection equipment installed at zone substations to gain benefits from reduced spares holdings, operator and maintenance staff familiarity and training requirements. The preferred relay types are detailed in Table 6.

Table 6: Preferred relay types

Description	Manufacturer	Model
Line current differential	AREVA/Schneider (formerly ALSTOM)	MiCOM P541 7SD610
	Siemens	
Transformer differential	AREVA/Schneider (formerly ALSTOM)	MiCOM P632
11 kV feeder protection	AREVA/Schneider (formerly ALSTOM)	MiCOM P143 Multilin SR760
	General Electric	
Bus couplers	AREVA/Schneider (formerly ALSTOM)	MiCOM P143 Multilin SR760
	General Electric	
SEF check	AREVA/Schneider (formerly ALSTOM)	MiCOM P122

Zone substation feeder relays are configured to provide a number of different settings groups including Live Line Settings On/Off, Auto-Reclose On/Off and Under-frequency Load Shedding On/Off.

Battery systems at zone substations are either 32 V DC or 125 V DC, in accordance with Table 5 above. TasNetworks mostly uses single battery chargers at zone substation sites. The risk in not having full redundancy (a second charger in parallel) has been mitigated by the following:

- a) designing batteries to withstand 8 hours on full station load;
- b) facilitating rapid deployment of back-up chargers with an external connection pedestal; and
- c) adequate spares holdings.

The modern batteries used within zone substations are relatively reliable with regards to asset life, so TasNetworks has moved to a program of replacing the zone substation batteries at ten-year intervals with no annual discharge testing. Any potential savings in life extension by annual discharge testing of the batteries to determine their condition were less than the cost of the discharge testing and battery maintenance.

TasNetworks' distribution SCADA system provides the following functionality:

- a) control and monitoring of all circuit breakers;
- b) control and monitoring of all transformers and AVRs;
- c) control and monitoring of all protection and metering units;
- d) monitoring of all station alarms; and
- e) remote indication of metered values.

The system provides unsolicited and report-by-exception polling operation over the TasNetworks fibre-optic Wide Area Network using DNP3 protocol.

The modernised zone substations have HMI stations which facilitate local operation, control, and provide engineering access for staff. In the event that the communication link to the Distribution Control is not operational, all substation alarms and annunciated points are available locally at the substation via the HMI.

SCADA system equipment utilised by TasNetworks consists of various:

- a) servers;
- b) work stations;
- c) gateway RTUs;
- d) HMI PCs;
- e) Ethernet media converters;
- f) firewalls;
- g) switches; and
- h) GPS time-clocks.

5 Associated risk

The level of risk pertaining to the protection and control assets and associated work programs is a function of both likelihood and consequence. Factors affecting the level of risk are listed as follows:

- a) age;
- b) location;
- c) data quality;
- d) financial;
- e) product support/obsolescence;
- f) reputation;
- g) connected load;
- h) regulatory/legal;
- i) network performance;
- j) safety;
- k) environment;
- l) customer considerations;
- m) trending; and
- n) benchmarking.

Risk levels are assessed against the TasNetworks risk management framework, which sets a consistent and structured approach to managing asset-related risk. The assessment of risk against this standard ensures that risk is controlled to a level that aligns with the TasNetworks risk appetite. Any risks which fall outside the permissible limits may require further control in the form of a risk treatment plan and are managed subjectively as required.

For further information relating to the risk levels for the protection and control asset class (distribution) refer to Appendix A.

5.1 Overhead assets

Overhead protection and control asset work program risk is generally quite low due to its low complexity and relatively low likelihood/consequence combined risk ratings. Maintenance tasks associated with overhead protection and control assets are straight forward and managed in accordance with corresponding maintenance intervals.

The program concerning SCADA communications to Cooper (voltage) regulators is considered low risk as this only relates to a small population of devices across the distribution network.

Communications operating costs are associated with the upkeep of mobile phone network services and is becoming increasingly important in today's operating environment. The risk is therefore considered medium-level.

The following table summarises the (unmanaged) risk levels for the various work programs pertaining to protection and control overhead assets:

Table 7: Overhead asset risk

Program	Category	Risk Assessment
Operating Costs for Modem Communications	PRCOM	Medium
Recloser & LBS Maintenance	AROPC	Low
Asset Repair OH Protection Switchgear Maintenance	AROPC	Low
Fault Indicator Maintenance	AROPC	Low
Replace LV Fuses for Fuse Reach	REOPC	Low
Replace Recloser & or Control Box	RERPC	Low
Install SCADA Communications to Cooper Regulators	PRCOO	Low

5.2 Ground mounted distribution substation assets

The ground mounted distribution substation asset work program mostly concerns maintenance and replacement activities on forty-year old protection and control equipment. Largely due to age and locality (the Critical Infrastructure reliability area in the Hobart CBD), the associated risk is considered medium in relation to TasNetworks’ risk framework.

The following table summarises the (unmanaged) risk levels for the various work programs pertaining to protection and control ground mounted distribution substation assets:

Table 8: Ground mounted distribution substation asset risk

Program	Category	Risk Assessment
Routine Maintenance Distribution Subs (Battery System Tests)	RMDPC	Medium
Routine Maintenance Distribution Subs (Protection System Tests)	RMDPC	Medium
Replace Battery (Once every 4 years same time as per protection test and switchgear maintenance)	REGAU	Medium
Replace Distribution Substation Battery System	REGAU	Medium

Distribution substation protection is comprised of electromechanical relays which service the pilot wire protection schemes throughout the Hobart CBD. TasNetworks recently became aware of the approaching obsolescence of one relay model, the Alstom MiDOS MHOB 04 Plain Feeder Protection Relay. Accordingly, a strategy revision was prompted which is discussed under Section 8.11.

5.3 Zone substations

The zone substation asset work program concerns maintenance and replacement programs on the 33/11kV substations across the distribution network. With large levels of customer load and high criticality, the risk has been assessed as medium for these programs.

The following table summarises the (unmanaged) risk levels for the various work programs pertaining to protection and control zone substation assets:

Table 9: Zone substation asset risk

Program	Category	Risk Assessment
Urban Zone Substation Protection and SCADA Maintenance	RMZPC	Medium

6 Key performance indicators

TasNetworks monitors distribution assets for major faults through its outage and incident reporting processes.

Asset failures resulting in unplanned outages are recorded in the InService outage management tool by field staff, with cause and consequence information being subsequently made available to staff for reporting and analysis. Those outages with a significant enough consequence are also recorded in RMSS and are investigated by the business to establish the root cause of the failure and to recommend remedial strategies to reduce the likelihood of reoccurrence of the failure mode. Reference to individual fault investigation reports can be found in RMSS.

TasNetworks also maintains a defect management system that enables internal performance monitoring and statistical analysis of asset faults and/or defects that either may not result in unplanned outages, or whose failure may only result in a minor consequence not requiring full investigation.

TasNetworks' Service Target Performance Incentive Scheme (STPIS), which meets the requirements of the Australian Energy Regulator's (AER's) Service Standards Guideline, imposes service performance measures and targets onto TasNetworks with a focus on outage duration and frequency. While the STPIS does not target specific asset classes, good asset performance will have a significant impact on TasNetworks' ability to meet the STPIS targets.

STPIS parameters include:

- a) System Average Interruption Duration Index (SAIDI); and
- b) System Average Interruption Frequency Index (SAIFI).

Details of the STPIS scheme and performance targets can be found in the "*Electricity distribution network service providers - Service target performance incentive scheme - November 2009*".

7 Benchmarking

TasNetworks participates and works closely with distribution companies in key industry forums such as CIGRE (International Council on Large Electric Systems), IEEE, ANSI, AS/NZ and Energy Networks Australia (ENA), to compare asset management practices and performance to ensure we keep abreast of industry good practice and contemporary asset management. In addition, affiliation and representation on Australian Standard and other international standards bodies helps TasNetworks maintain influence on designs and standards and ensure that TasNetworks maintains a strong asset management focus with the objective being continually improvement.

8 Management plan

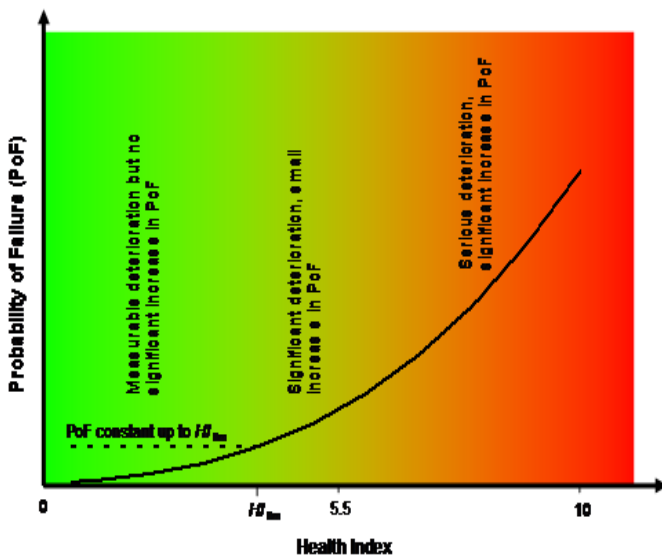
8.1 Lifecycle management plan

The life-cycle management of distribution protection and control assets is based on achieving the maximum availability of the asset for the lowest life-cycle cost. This process begins prior to the purchase of the device with standards and designs management to ensure that all assets purchased are specified to fully meet TasNetworks technical design requirements and constructed to the prescribed quality standards.

The failure of distribution protection and control assets can be shown to follow the classic ‘bath tub’ curve. This implies that transformers are more likely to fail at either the beginning or end of their lives. As shown in the probability of failure increases exponentially as the asset approaches end of life. Prudent monitoring and maintenance at this critical life stage can help prevent many unplanned outages. Failures which occur at infancy and during the normal lifespan can generally be considered as random failures.

Asset management strategies, techniques and practices are constantly being reviewed and aligned with contemporary asset management principles.

Figure 4: Deriving a probability of failure



8.2 Historical

The Protection and Control – Distribution asset thread became detached from the Overhead and Structures and Substations and Underground threads in 2012. Prior to this protection and control asset management activities were undertaken under each respective thread whereby most of the initiatives were OPEX and maintenance based. In 2012/13 the maintenance activities pertaining to protection and control were combined under one thread and additional OPEX and CAPEX-based initiatives were introduced as a new strategic focus began. This included various remote communications programs including substations switchgear and voltage regulators.

Subsequently the spend profile for the Protection and Control Thread does not precede the 2012/13 financial year.

8.2.1 Overhead assets

Asset management programs pertaining to overhead (secondary) assets are listed as follows:

Table 10: Overhead protection and control work programs

CAPEX/OPEX	Work Program Level	Project/Program Description	Category Code
OPEX	Operating costs other	Operating Costs for Modem Communications	PRCOM
OPEX	Non-routine	Recloser & LBS Maintenance	AROCP

	maintenance		
OPEX	Non-routine maintenance	Asset Repair OH Protection Switchgear Maintenance	AROPC
OPEX	Non-routine maintenance	Fault Indicator Maintenance	AROPC
CAPEX	Reliability & quality maintained	Replace LV Fuses for Fuse Reach	REOPC
CAPEX	Reliability & quality maintained	Replace Recloser & or Control Box	RERPC
CAPEX	SCADA & Network Control	Install SCADA Communications to Cooper Regulators	PRCOO

8.3 Ground mounted distribution substation assets

Asset management programs pertaining to ground-mounted distribution substation (secondary) assets are listed as follows.

Table 11: Ground mounted distribution substation work programs

CAPEX/ OPEX	Work Program Level	Project/Program Description	Category Code
OPEX	Routine maintenance	Routine Maintenance Distribution Subs (Battery System Tests)	RMDPC
OPEX	Routine maintenance	Routine Maintenance Distribution Subs (Protection System Tests)	RMDPC
CAPEX	Reliability & quality maintained	Replace Battery (Once every 4 years same time as per protection test and switchgear maintenance)	REGAU
CAPEX	Reliability & quality maintained	Replace Distribution Substation Battery System	REGAU

8.4 Zone substation assets

Asset management programs pertaining to zone substation (secondary) assets are listed as follows.

Table 12: Zone substation work programs

CAPEX/ OPEX	Work Program Level	Project/Program Description	Category Code
OPEX	Routine maintenance	Urban Zone Substation Protection and SCADA Maintenance	RMZPC
OPEX	Routine maintenance	Battery and Charger Maintenance - Zone Substation	RMZPC

8.5 Strategy

The asset management strategies pertaining to the distribution Protection and Control asset class are described in the subsequent sections.

8.5.1 CAPEX versus OPEX

The Control aspect of Protection and Control management provides opportunities to trade operating expenses for capital investment effectively. Remote controlling distribution network devices for network control can provide significant savings in operational costs versus manual switching. The Protection and Control Thread works closely with Network Innovation in actively seeking these opportunities.

Remote control is most cost effectively introduced through new equipment with factory fitted capabilities, and is becoming a common feature of new switchgear. TasNetworks expects this to be a standard feature of all new switchgear in the near future, and considers these features when renewing switchgear supply period contracts.

The Protection and Control Thread is also taking the opportunity to capitalise the replacement of batteries in distribution substations by introducing a cyclic replacement program, as an alternative to performing routine battery testing. This aligns with a key TasNetworks strategic focus in meeting customer needs at the lowest sustainable cost.

A cyclic battery replacement program for zone substations has also recently been introduced to the Program of Work, to reduce operational expenditure associated with routine testing.

8.5.2 Replace versus retrofit

The implementation of remote control of zone and distribution substations, reclosers and switches can be achieved through either retrofitting of remote control equipment or replacement with equipment that has the facilities.

Where switchgear can be retrofitted with motorised spring chargers to provide remote control functionality (certain Schneider and Brown Boveri switchgear), they will be investigated as potential remote control projects associated under the Protection and Control POW. New and emerging remote control technologies are first trialled under Network Innovations' work programs.

Where retrofitting is not an option then remote control is implemented when asset management requirements necessitate asset replacement. This is carried out in conjunction with the Substations and Underground Thread.

8.5.3 Routine maintenance

There is a fundamental requirement for TasNetworks to periodically inspect the assets to ensure their physical state and condition does not represent a hazard to the public. Other than visiting the assets, there is no other economic solution to satisfy this requirement, although some asset statuses can be monitored remotely once a device has been equipped with remote communications.

8.5.4 Routine maintenance versus non routine maintenance

Distribution protection and control asset failure may cause serious or catastrophic damage to the associated primary asset. These assets are generally located in close proximity to the public, so allowing failures to occur represents a significant risk to the public and surrounding infrastructure. These assets also have a high unit value, so a preventative corrective maintenance program represents a cost effective alternative to a reactive corrective maintenance program.

8.5.5 Refurbishment

Where distribution protection and control assets are removed from the network in good operating condition by activities such as capacity and power quality drivers, these assets are assessed for redeployment back into the network where such refurbishment is deemed to be an economic proposition.

8.5.6 Planned asset replacement versus reactive asset replacement

A reactive replacement generally does not represent an attractive alternative to a planned renewal activity. Distribution protection and control assets are predominately servicing high density urban, commercial or CBD communities, with a high service level expectation in the Tasmanian Electricity Code. Also reactive replacements are generally several times more expensive, incurring overtime, call out penalties and additional repair costs to cable terminations and nearby infrastructure.

Replacement is generally only preferred when this is a more economic proposition compared to ongoing maintenance costs over the estimated remaining service life of the asset. These are identified from the maintenance and inspections activities and feed into the list of proposed capital expenditure projects for prioritisation.

8.5.7 Non network solutions

Protection systems provide an essential function in providing protection from the release of large amounts of damaging energy. In general there are no non-network solutions that provide this protection function.

Control systems equipment however, forms part of the Network Innovation team's portfolio and they spend considerable time evaluating new and emerging technologies. The Protection and Control Thread work closely with the Network Innovation team in this regard.

The introduction of some non-network solutions such as embedded generation adversely impact protection systems through increased fault levels and changes in power flow direction. Network Innovation and Strategic Asset Management will jointly manage this issue.

8.5.8 New technology

Modern protection systems, through their implementation in microprocessor-controlled relays, are changing rapidly as new technological improvements continue. New technology will continue to be trialled by TasNetworks and implemented where cost/benefits exist.

8.6 Routine maintenance

The following sections outline the routine maintenance programs for this asset class.

8.6.1 Routine maintenance distribution subs (battery system tests) - RMDPC

This operational program concerns the maintenance of ground-mounted substation DC battery systems to ensure correct ongoing operation. Activities include discharge tests on battery systems and the replacement of individual charger components or cells where necessary. The maintenance interval for these activities is six-monthly. This program does not concern battery systems recently upgraded as part of the associated CAPEX-based battery system replacement program (REGAU, Section 8.8.4) but rather, the older systems yet to be replaced. As the CAPEX program advances, the volumes tested under this battery system testing program will decrease until eventually no longer required.

This program has been developed to manage associated asset risk in accordance with TasNetworks' risk framework. It also aligns with a key TasNetworks strategic focus in meeting customer needs at the lowest sustainable cost.

8.6.2 Routine maintenance distribution subs (protection system tests) - RMDPC

This operational program concerns the maintenance of ground-mounted substation protection systems to ensure correct ongoing operation. Activities include secondary injection and functional testing of relays and pilot wire circuit integrity testing. The maintenance interval for these activities is four-yearly. Asset repairs are raised as required for defects identified during the site visit. Unlike Section 8.6.1, this program includes all ground-mounted substations in the fleet (which have DC-powered protection systems, known as Translay).

This program has been developed to manage associated asset risk in accordance with TasNetworks' risk framework, and is an essential program in ensuring the ongoing protection of all associated primary equipment.

8.6.3 Battery and charger maintenance - zone substation - RMZPC

This operational program concerns maintenance of zone substation DC battery systems to ensure correct ongoing operation. Activities include discharge tests on battery systems and the replacement of individual charger components or cells where necessary. The maintenance interval for these activities is twelve-monthly. The discharge testing component pertains to zone substation sites yet to have battery banks upgraded under the associated CAPEX-based battery replacement program (REUZO). Once all sites receive new battery banks, the OPEX-based testing regime can be phased out, leaving a residual program funding portion for ongoing charger maintenance.

8.6.4 Urban zone substation protection and SCADA maintenance - RMZPC

This operational program concerns the maintenance activities associated with the protection and SCADA systems at TasNetworks' 12 zone substations. Activities include:

- a) primary/secondary injection and functional testing of relays and protection schemes;
- b) insulation resistance of CT/VT secondary wiring;
- c) testing of trip circuitry;
- d) device setting back-up;
- e) spares management;
- f) software version control and licensing management;
- g) equipment calibration;
- h) visual checks and inspections;
- i) cleaning of secondary equipment;
- j) fault response;
- k) incident investigations; and
- l) ad-hoc works.

The maintenance intervals for these activities vary between monthly to four-yearly in accordance with the following table:

Table 13: Zone substation maintenance intervals

Classification	Frequency
Protection testing, calibration	Every four years
Device setting back-up, cleaning, software	Twelve-monthly

Inspections, checks	Monthly
Fault response, ad-hoc works, investigations	As required

Until August 2015 the entire program services were provided by an external contractor, selected through a competitive tender process. Following the recent merger, in-house expertise was gained allowing these activities to be provided internally minus fault response and some ad-hoc works.

Since the advent of numerical relays with watch-dog alarming, the opportunity exists to extend maintenance intervals. Whilst the opportunity exists to push injection testing regimes out further, TasNetworks considers four-yearly intervals the most appropriate maintenance frequency since the associated primary equipment (CTs and VTs) are all original, having not been replaced as part of any recent modernisation projects.

This program has been developed to manage associated asset risk in accordance with TasNetworks' risk framework, and is an essential program in ensuring the ongoing protection of all associated primary equipment.

8.7 Non routine maintenance

The following sections outline the non-routine maintenance programs for this asset class.

8.7.1 Recloser and LBS maintenance - AROPC

This operational program relates to the replacement of batteries in recloser and load break switch (LBS) controllers on a five-year cycle. The recloser/LBS fleet in the distribution network is divided evenly across the five year maintenance period in accordance with locality. This enables efficient use of resources in delivering this program.

This program is essential in safeguarding recloser/LBS devices from failing in service, especially reclosers which have important protection functions. It has been developed in accordance with TasNetworks' risk framework.

8.7.2 Asset repair OH protection switchgear maintenance - AROPC

This operational program concerns the activities associated with the repair of reclosers and load break switches (excluding primary equipment). Activities include the repair of control cabling, circuit boards, power supplies, communications equipment and fusing.

This work is mostly reactive and is performed as equipment fails in service. Volumes are based on historical figures. This program has been developed in accordance with TasNetworks' risk framework.

8.7.3 Fault indicator maintenance - AROPC

In similar regard to Section 8.7.1 the (overhead lines) fault indicator maintenance program (opex) is related to the replacement of batteries on a five-year cycle. Other activities include modifying connections to facilitate a faster battery change-over and cleaning the device solar panel.

TasNetworks has two types of overhead proximity fault indicator:

- a) CHK RPU3-S4; and
- b) GridSense LT 30.

This program has been developed to ensure the ongoing reliability of the overhead fault indicator fleet. These devices are instrumental in reducing outage times as a result of extended fault patrols. It has been developed in accordance with TasNetworks' risk framework.

8.8 Reliability and quality maintained

The following sections outline the 'reliability and quality maintained' programs for this asset class.

8.8.1 Replace LV fuses for fuse reach - REOPC

The aim of this capital program is to proactively evaluate and redesign/repair substandard LV sites to ensure that under fault conditions the LV network is appropriately protected. This program is related to a program in the Overhead and Structures thread, REOHQ Replace OH Switchgear, which also aims to reduce the risk associated with LV links and fuses.

The difference between the two programs is:

- a) REOHQ simply replaces the LV links on a transformer with an LV fuse sized to the size of the transformer; and
- b) this program has a design component to ensure the fuse is sized to protect the whole LV circuit and may require the reconfiguration of LV circuits.

This program aims to address 260 sites per year, starting with sites that have no LV protection.

8.8.2 Replace recloser and/or control box - RERPC

This capital program is a reactive program developed to substitute damaged or faulty controllers or associated circuit boards. Volumes are based on historical overhead switchgear controller failure data.

8.8.3 Replace battery (distribution substation) - REGAU

This capital program concerns the replacement of ground-mounted substation 32 V battery banks at four-yearly intervals, at the same time the protection testing regime is delivered under the associated operational program, RMDPC (refer to Section 8.6.2). This program applies to all distribution substation sites which have had battery systems upgraded in accordance with the 'Replace Battery System' Capex program per Section 8.8.4.

This program has been developed to manage associated asset risk in accordance with TasNetworks' risk framework, and is an essential program in ensuring the ongoing protection of all associated primary equipment.

8.8.4 Replace distribution substation battery system - REGAU

This capital program is associated with the replacement of old ground-mounted substation battery chargers which in some cases are as old as 25 years. The replacement chargers are equipped with remote monitoring facilities which will allow TasNetworks to move away from 6-monthly inspection activities. As this program is delivered, the volumes under RMDPC (Section 8.6.1) will reduce to nil resulting in significant operational savings.

This program has been developed to manage associated asset risk in accordance with TasNetworks' risk framework, and is an essential program in ensuring the ongoing protection of all associated primary equipment.

8.9 SCADA & network control

8.9.1 Install SCADA communications to Cooper regulators - PRCOO

This capital program involves retrofitting Cooper single phase high voltage regulators with communications hardware to provide for remote monitoring and control.

The aim of this program is to reduce operational expenditure associated with:

- a) manually operating the equipment under various contingencies; and
- b) performing periodic load checks and other routine tests.

This program is split according to Northern, North Western and Southern areas.

The program has been developed in consultation with Distribution Operations to manage risk, with a focus on key feeders likely to be paralleled under fault conditions.

8.10 Operating costs other

8.10.1.1 Operating costs for modem communications - PRCOM

This program provides operational expenditure to cover account charges for protection and control Next-G communications devices. Distribution network equipment utilising remote communications devices is listed as follows:

- a) reclosers;
- b) load break switches;
- c) fault indicators;
- d) capacitor banks;
- e) fuse savers;
- f) voltage regulators; and
- g) ground-mounted substations.

TasNetworks utilises Telstra Next-G at present, and has recently moved from simple dial-up communications to 'always on' wireless IP communications. This has a marginal cost increase but it provides a significant performance increase and additional functional benefits.

8.11 Future regulatory period planned works

8.11.1 Translay relay replacement

TasNetworks owns and maintains an aged fleet of electromechanical protection and control assets in this reliability area with an average age of 37.59 years (2013/14). The relays form part of a unit protection scheme known by the tradename, Translay. Faced with significant issues such as obsolescence and age, TasNetworks wishes to invest in this infrastructure in order to meet the needs of the network, taking into consideration the reliability requirements of the area and the projected load growth. There are 445 Translay and associated relays in this asset fleet, protecting 87 feeder segments.

TasNetworks' planned solution is to replace the Translay and associated relays with modern numeric equivalents based on age profile and a nominal forty year life cycle. Along-side will be with a staged fibre-optic cable installation to replace the aged pilot wire network. The new Translay relays will be compatible with both fibre-optic and pilot wire communication systems and will facilitate connection to either communications medium, based on how advanced the fibre-optic upgrade is.

8.11.2 Fault indicator replacements

In relation to fault indicators; TasNetworks' efforts to date have only been concerned with battery replacements. Based on an average age extending to the early 1990s, future work programs have been developed to replace these devices in their entirety to ensure a healthy working asset class over the next ten years.

Replacement programs have been developed for both ground-mounted and overhead fault indicators, with a small percentage of each planned to be equipped with remote communications for increased visibility and fault response capability.

8.11.3 Ground-mounted voltage regulator SCADA upgrades

TasNetworks has a fleet of 33 ground-mounted voltage regulators and plans are to introduce SCADA communications (by installing new AVR's) to 13 of these sites over the forthcoming regulatory period. Sites will be chosen based on maximum operational benefit in consultation with key performance and operations staff.

8.11.4 Recloser Secondary Injection Testing

This new program involves performing secondary injection testing on 10% of the recloser fleet (per year) based on a 10-year cyclic regime. This is being introduced to help in managing risk associated with an ageing recloser fleet, to ensure the protection will operate as designed.

8.12 Regulatory obligations

The lead regulatory obligations to be met are National Electricity Rules clauses S5.1a.8, Fault clearance times and S5.1.9(c) Protection systems and fault clearance times. In addition to meeting these obligations protection and control is key to maintaining the performance to the Reliability Standards in the Tasmanian Electricity Code.

Key considerations in meeting the aforementioned are as follows.

8.12.1 Maintain network performance

Accurate discrimination of protection systems will isolate faulted areas, disconnect the minimum number of customers, and minimise impacts on reliability performance. The coordination between protection devices needs to be monitored and maintained as the network grows and develops over time.

Fast protection operation time will minimise asset damage and customer impacts from voltage dips due to reflected faults on the network.

8.12.2 Manage business operating risks at an appropriate level

Protection Systems provide protection to assets to minimise the severity of asset damage under fault conditions.

The operation of protection and control devices must remain safe under a growing and developing network.

8.13 Investment evaluation

Investment evaluation is undertaken using TasNetworks' Investment Evaluation Summary template. The template includes:

- a) a brief description of the asset(s);
- b) a description of the issues and investment drivers;
- c) alignment with regulatory objectives;
- d) alignment with TasNetworks' corporate objectives;
- e) alignment with TasNetworks' corporate risks;
- f) impacts to customers;

- g) analysis of options to rectify the issues including operational and capital expenditures;
- h) a summary of NPV economic analysis for the identified options;
- i) the preferred option and why;
- j) the timing of the investment; and
- k) the expected outcomes and benefits.

8.14 Spares management

The management of spares is a joint strategic and operational responsibility across TasNetworks and is key in managing asset risk. Deficiencies in spares holdings are identified during the asset management plan development and where these models of protection relay are not obsolete, spares are ordered in alignment with TasNetworks' spares policy.

8.15 Disposal plan

Distribution protection and control equipment that has been removed from service as part of either a capital replacement project or an Opex-based maintenance activity are disposed of by the project staff. Asset types which are not obsolete may be refurbished and retained for system spares, as identified by TasNetworks operational staff.

8.16 Summary of programs

Table 14 provides a summary of all of the programs described in this management plan under both:

- a) the 15/16 Program of Work cycle; and
- b) the current asset management plan review cycle.

Table 14: Summary of distribution protection and control programs

CAPEX / OPEX	Work Program Level	Project/Program Description	Category Code
OPEX	Operating costs other	Operating Costs for Modem Communications	PRCOM
OPEX	Non-routine maintenance	Recloser & LBS Maintenance	AROPC
OPEX	Non-routine maintenance	Asset Repair OH Protection Switchgear Maintenance	AROPC
OPEX	Non-routine maintenance	Fault Indicator Maintenance	AROPC
OPEX	Routine maintenance	Routine Maintenance Distribution Subs (Battery System Tests)	RMDPC
OPEX	Routine maintenance	Routine Maintenance Distribution Subs (Protection System Tests)	RMDPC
OPEX	Routine maintenance	Urban Zone Substation Protection and SCADA Maintenance	RMZPC
OPEX	Routine maintenance	Battery and Charger Maintenance - Zone Substation	RMZPC
CAPEX	Reliability & quality maintained	Replace LV Fuses for Fuse Reach	REOPC
CAPEX	Reliability & quality maintained	Replace Recloser & or Control Box	RERPC

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CAPEX	SCADA & Network Control	Install SCADA Communications to Cooper Regulators	PRCOO
CAPEX	Reliability & quality maintained	Replace Battery (Once every 4 years same time as per protection test and switchgear maintenance)	REGAU
CAPEX	Reliability & quality maintained	Replace Distribution Substation Battery System	REGAU

10 Financial summary

10.1 Program delivery

TasNetworks makes a concerted effort to prepare a considered deliverability strategy based on the planned operational and capital program of work for distribution network assets. A number of factors contribute to the successful delivery of the program of work. These factors are utilised as inputs to prioritise and optimise the program of work, to ensure sustainable and efficient delivery is maintained. This program prioritisation or optimisation can impact delivery of individual work programs, to favour delivery of other programs. Factors considered include:

- a) customer-driven work we must address under the National Electricity Customer Framework (NECF);
- b) priority defects identified through inspection and routine maintenance activities;
- c) identified asset risks as they relate to safety, the environment and the reliability of the electrical system;
- d) adverse impacts of severe storms and bushfire events;
- e) system outage constraints;
- f) changes to individual project or program delivery strategy;
- g) size and capability of its workforce;
- h) support from external contract resources and supplementary service provision;
- i) long lead equipment and materials issues;
- j) resolution of specific technical and functional requirement issues;
- k) complex design/construct projects with long lead times;
- l) approvals, land acquisition or wayleaves; and
- m) access issues.

Specific to the Protection and Control - Distribution asset management plan, these factors have resulted in the (essentially) successful delivery of the operational and delayed delivery of the capital programs of work.

10.2 Proposed OPEX expenditure plan

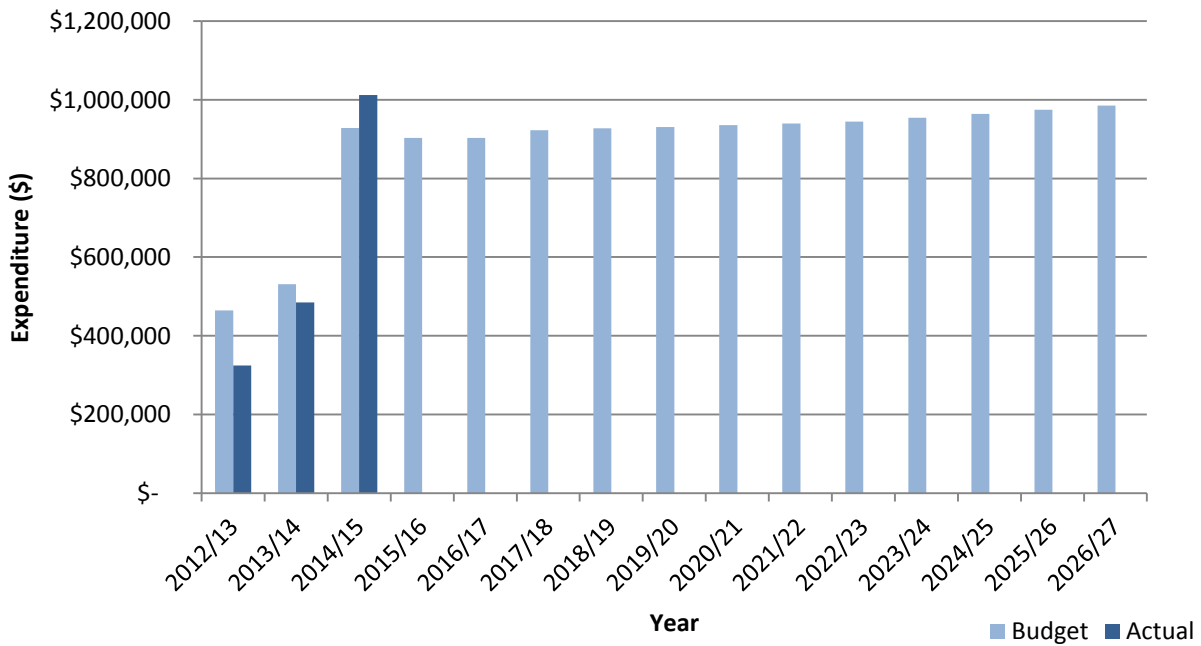
The operational programs and expenditure identified in this management plan are necessary to manage operational and safety risks and maintain network reliably at an acceptable level. All operational expenditure is prioritised expenditure based on current condition data, field failure rates and prudent risk management in accordance with TasNetworks' risk management framework.

Table 15 shows the historical operational expenditure and the proposed future spend.

Table 15: OPEX for the period 2012/13 to 2019/20

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Budget	\$464,206	\$530,939	\$928,320	\$903,000	\$903,000	\$922,173	\$927,114	\$930,707
Actual	\$476,695	\$485,313	\$1,012,000					

Figure 5: Total OPEX actuals, with forecast to 2026/27



The increase in OPEX from 2013/14 to 2014/15 is attributable to:

- a) the acceleration of a fault indicator restoration program under a previous leadership reliability strategy known as “Cause and Effect”; and
- b) the increase of asset repair budgets to align with the number of HV switchgear failures being experienced in the field.

The increase in OPEX in relation to the forthcoming regulatory period may be attributable to the introduction of the recloser secondary injection testing program (Section 8.11), and an increase in the overall devices numbers for which OPEX maintenance regimes are required.

10.3 Proposed CAPEX expenditure plan

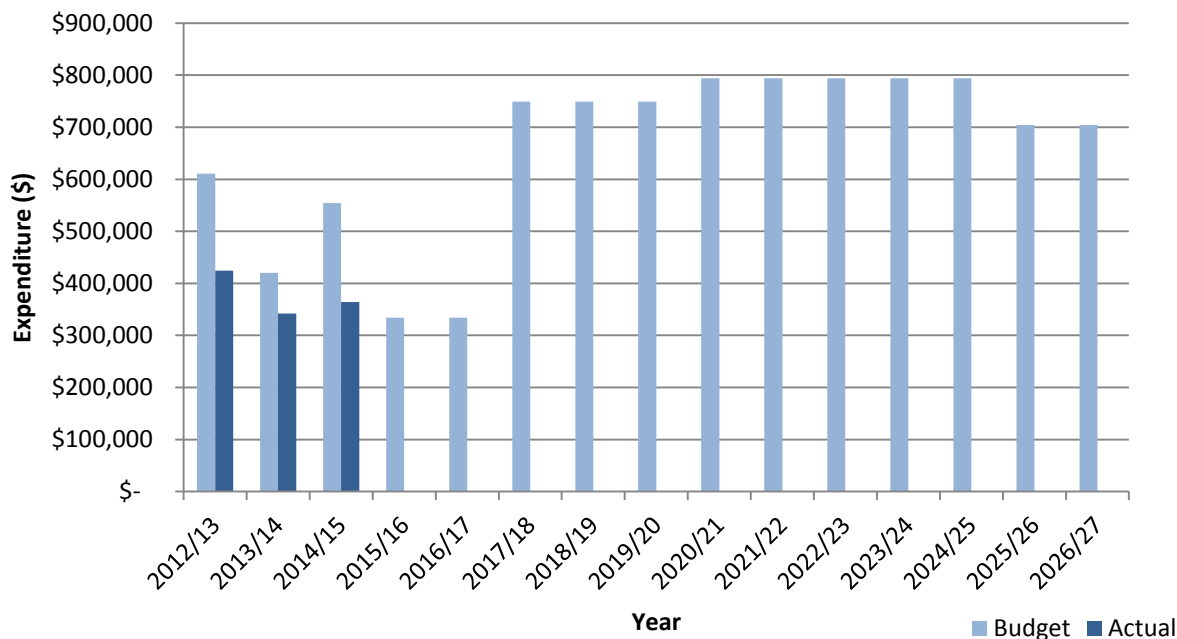
The capital programs and expenditure identified in this management plan are necessary to manage operational and safety risks and maintain network reliably at an acceptable level. All capital expenditure is prioritised expenditure based on current condition data, field failure rates and prudent risk management in accordance with TasNetworks’ risk management framework.

Table 16 shows the historical operational expenditure and the proposed future spend.

Table 16: CAPEX for the period 2012/13 to 2019/20

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Budget	\$610,606	\$420,128	\$554,000	\$334,000	\$334,000	\$749,368	\$749,368	\$749,368
Actual	\$424,319	\$342,198	\$364,000					

Figure 6: Total CAPEX actuals, with forecast to 2026/27



The increase in CAPEX over the forthcoming regulatory period is attributable to the introduction of a number of key programs which have been designed to manage TasNetworks’ risk. These programs are discussed in Section 8.11.

11 Responsibilities

Maintenance and implementation of this management plan is the responsibility of the Asset Strategy Team.

Approval of this management plan is the responsibility of the Asset Strategy and Performance Leader.

12 Related standards and documentation

The following documents have been used in the development of this management plan, or provide supporting information to it:

- a) R040766 TasNetworks Asset Management Policy;
- b) R231574 Distribution Standard Protection and Control;
- c) R301624 Underground System Asset Management Plan;
- d) R181933 Overhead Switchgear Asset Management Plan;
- e) R301380 Zone Substations Asset Management Plan;
- f) R209871 TasNetworks – Risk Management Framework;
- g) R209885 TasNetworks – Risk Appetite Statement; and
- h) R209890 TasNetworks – Risk Metrics.

Appendix A Summary of key programs and risk

Description	Work Category	Risk Level	Driver	Expenditure Type	Residual Risk	12/13 Budgeted	13/14 Budgeted	14/15 Budgeted	15/16 Budgeted	16/17 Budgeted
Operating Costs for Modem Communications	PRCOM	Med	Safety/Reliability	OPEX	Low	\$270k	\$225k	\$240k	\$250k	\$261k
Recloser & LBS Maintenance	AROPC	Low	Safety/Reliability	OPEX	Low	\$59k	\$59k	\$68k	\$70k	\$70k
Asset Repair OH Protection Switchgear Maintenance	AROPC	Low	Safety/Reliability	OPEX	Low	\$41k	\$41k	\$100k	\$140k	\$140k
Fault Indicator Maintenance	AROPC	Low	Safety/Reliability	OPEX	Low	\$50k	\$35k	\$125k	\$125k	\$45k
Routine Maintenance Distribution Subs (Battery System Tests)	RMDPC	Med	Safety/Reliability	OPEX	Low	\$25k	\$25k	\$26k	\$50k	\$41k
Routine Maintenance Distribution Subs (Protection System Tests)	RMDPC	Med	Safety/Reliability	OPEX	Low	\$25k	\$25k	\$42k	\$43k	\$55k
Urban Zone Substation Protection and SCADA Maintenance	RMZPC	Med	Safety/Reliability	OPEX	Low	\$132k	\$160k	\$195k	\$200k	\$217k
Battery and Charger Maintenance - Zone Substation	RMZPC	Med	Safety/Reliability	OPEX	Low	\$20k	\$20k	\$7k	\$15k	\$18k
Replace LV Fuses for Fuse Reach	REOPC	Low	Safety/Reliability	CAPEX	Low	\$20k	\$20k	\$20k	\$20k	\$24k
Replace Recloser & or Control Box	RERPC	Low	Safety/Reliability	CAPEX	Low	\$24k	\$24k	\$24k	\$24k	\$133k
Install SCADA Communications to Cooper Regulators	PRCOO	Low	Safety/Reliability	CAPEX	Low	\$230k	\$75k	\$98k	\$90k	\$0k
Replace Battery (Once every 4 years same time as per protection test and switchgear maintenance)	REGAU	Med	Safety/Reliability	CAPEX	Low	\$20k	\$20k	\$20k	\$20k	\$0k
Replace Distribution Substation Battery System	REGAU	Med	Safety/Reliability	CAPEX	Low	\$50k	\$400k	\$400k	\$180k	\$180k