Asset Management Plan

Circuit Rating and Weather Monitoring System

Asset Management Plan

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Responsibilities

This document is the responsibility of the Asset Strategy Team, Tasmanian Networks Pty Ltd, ABN 24 167 357 299 (hereafter referred to as "TasNetworks").

The approval of this document is the responsibility of the General Manager, Strategic Asset Management.

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- Implementation All TasNetworks staff and contractors.
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1 Purpose

The purpose of this document is to describe for transmission circuit rating and weather monitoring strategies and related assets:

- TasNetworks' approach to asset management, as reflected through its legislative and regulatory obligations and strategic plans
- The key projects and programs underpinning its activities

2 Scope

This asset management plan covers all circuit rating and weather monitoring system assets. These include, but are not limited to, conductor tension monitors and weather stations.

3 Strategic alignment and objectives

This asset management plan has been developed to align with both TasNetworks' Asset Management Policy and Strategic Objectives. This management plan describes the asset management strategies and programs developed to manage the transmission circuit rating and weather monitoring, with the aim of achieving these objectives.

For these assets the management strategy focuses on the following objectives:

- Safety will continue to be our top priority and we will continue to ensure that our safety performance continues to improve
- 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
- Cost performance will be improved through prioritisation and efficiency improvements that enable us provide predictable and lowest sustainable pricing to our customers
- Customer engagement will be improved to ensure that we understand customer needs, and incorporate these into our decision making to maximise value to them
- Our program of work will be developed and delivered on time and within budget

4 Asset information systems

4.1 Systems

TasNetworks maintains an asset management information system (AMIS) that contains detailed information relating to the circuit rating and weather monitoring system population. AMIS is a combination of people processes, and technology applied to provide the essential outputs for effective asset management, such as:

- reduced risk;
- enhanced transmission system performance;
- enhanced compliance, effective knowledge management;
- effective resource management; and
- optimum infrastructure investment.

Currently individual circuit rating and weather monitoring assets are located in the Works, Assets, Solutions and People (WASP) Asset management register. The WASP asset management register will be replaced in 2018 as part of the Ajilis Transformation program.

TasNetworks Geographic Information System (GIS) also captures asset data associated with transmission lines. This data is stored in a standalone database with links into WASP.

5 Description of the assets

Circuit rating and weather monitoring systems calculate transmission line current ratings in real time, using meteorological data gathered though weather stations. These are an integral part of TasNetworks' transmission line circuit rating system. Systems comprise of:

- tension monitors;
- weather stations;
- TRCalc real time rating software; and
- Rating Information System (RIS).

5.1 Transmission line support structure foundation types

TasNetworks maintains 15 weather stations (including tension monitoring) and 2 tension monitoring stations. A summary of stations is provided in **Error! Reference source not found.**.

Circuit rating software, 'TRCalc' is used to calculate ratings in real-time from data gathered from the weather station facilities.

Table 1 – Weather and tension monitoring station summary

										Power supply			
SITE	Tension load cells	Temperature	Humidity	Wind speed	Wind direction	Solar (direct)	Solar (reflected)	Rainfall	Campbell Logger	AC	Solar	Wind	Fuel Cell
Burnie Substation		1	1	1	1	1		1		✓			
Chapel Street Substation		1	1	1	1	1		1		✓			
Creek Road Substation		1	1	1	1	1		1		✓			
Devonport Substation		1	1	1	1	1		1		✓			
Farrell Substation		1	1	1	1	1	1	1		✓			
TL516 GO-CS Tower T130 220kV (de-icing stn)	6								Y		✓		✓
TL516 GO-CS Tower T133 220kV		1	1	2	1	1		1	Y		✓	✓	
Hadspen Substation Tower T151A		1	1	2	1	1	1			✓			
TL500 LI-CS Tower T16 220kV	2	1	1	1	1				Y		✓		
TL500 LI-CS Tower T102 220kV	2	1		1	1	1	1		Y		✓		
TL509 PM-GT Tower T242 220kV		1	1	1	1	1	1		Y	✓	✓		
TL509 PM-GT Tower T60 220kV	2	1		1	1	1	1		Y		✓		
TL413 PM-TR Tower T119 110kV	2										✓		
TL503 PM-SH Tower T66 220kV	1	1		1	1		1		Y		✓		
Sheffield Substation		1	1	1	1	1		1		✓			
Trevallyn Substation		1	1	1	1	1		1		✓			
TL426 TU-WA Tower T130 110kV	1	1	1	1	1				Y		✓		
Poatina Winch house repeater for T60 and T66										✓			

5.1.1 Tension Monitors

Tension monitors are located on the circuit between the conductor and the connection to the tower. The conductor tensions are measured and telemetered to TasNetworks' control room via remote terminal units (RTUs) at remote substations. These values are converted to conductor temperatures using a polynomial equation. These temperatures are presently used to check TRCalc derived ratings on those circuits where tension monitors are installed.

Of those sites where tension monitors are installed, the station at tower T130 on the Gordon–Chapel Street 220 kV transmission line is used to control snow loading on this transmission line. This is accomplished by pre-emptive action to maintain conductors relatively free of ice, using real time data as well as impending weather, ambient temperature, rate of precipitation, and conductor tension to define an appropriate level of generation scheduling that will warm the conductors and prevent ice from accumulating.

5.1.2 Weather Stations

TasNetworks owns and operates a network of weather stations located throughout the state. These are utilised to gather a variety of meteorological parameters used in the calculation of real-time transmission line ratings. Weather information is telemetered from these remote stations to TasNetworks' control room via RTUs at substations.

TRCalc uses temperature, wind, solar information and voltage to calculate real time transmission circuit ratings.

5.1.3 TRCalc real time rating program

TRCalc models conductor temperature to ensure that transmission lines are operated within their thermal and minimum ground clearance limits. Without this data the transmission lines must revert to conservative workbook ratings to prevent excessive sagging and conductor damage.

TasNetworks supplies transmission line ratings to AEMO to maximise power transmission in support of energy trading. Should weather information be unavailable, the standard workbook values based on date and time of day are used by AEMO to forecast transmission capacity to the market. In most cases, the application of workbook values will result in lower transmission capacity in comparison to when real-time data is utilised.

5.1.4 Thermal calculator static rating calculation program

The thermal calculator is a spreadsheet tool which uses conductor, circuit and ambient parameters to calculate the current carrying capacity of a circuit. It is used in the planning, outage co-ordination and operational environment where the input parameters can be varied according to the study requirements.

5.2 Age profile

Weather and tension monitoring stations have been installed since 1997. Considering that almost all weather station assets are electronic and have a service life of between 10 and 15 years, these assets are now considered to be at end of life.

The circuit rating and weather monitoring system assets have an economic asset life of 15 years as defined by Sinclair Knight Merz (SKM) in its 'Assessment of Proposed Regulatory Asset Lives' report prepared in August 2013[1].

[1] TRIM D13/39576 'Assessment of proposed regulatory asset lives – August 2013', SKM

6 Standard of service

Failure of the electronic components that comprise the circuit rating and weather monitoring systems is difficult to predict and typically exhibit random failures. Regular maintenance is carried out through a bi-annual servicing and calibration program (prior to the winter and summer seasons). TasNetworks has a contract with a service provider for the bi-annual calibration, servicing and fault rectification of the circuit rating and weather monitoring systems and associated communication links. This contract does not include 24 hour emergency fault rectification call outs. Faults are reported to the service provider, and they are attended to at the earliest possible opportunity subject to weather conditions and resource availability.

In the event of a weather station fault or communication link failure, and as weather information becomes unavailable from a particular location, TRCalc can use alternative nearby sensors from three levels of backup.

Wherever faulty, custom or obsolete components are identified they will be replaced with the latest commercially available parts where possible, thus upgrading the weather or tension station.

6.1 Performance objectives

Performance levels of TasNetworks' circuit rating and weather monitoring system population are assessed using a combination of internal performance monitoring measures and external benchmarking.

6.1.1 Service obligations for network assets

TasNetworks' performance incentive (PI) scheme, which is derived from the AER Service Standards Guideline, is based on plant and supply availability. The PI scheme includes the following specific measures regarding plant availability:

- transmission line critical circuit availability;
- transmission line non-critical circuit availability;
- transformer circuit availability;

Additionally the PI scheme includes the following specific measures regarding loss-of-supply event frequency:

- number of events in which loss of supply exceeds 0.1 system minutes; and
- number of events in which loss of supply exceeds 1.0 system minutes.

Details of the PI scheme and performance targets can be found in TasNetworks' Transmission System Management Plan (TSMP).

6.1.2 Service obligations for non-regulated assets

6.1.2.1 Hydro Tasmania

TasNetworks has a PI scheme in place with Hydro Tasmania under its Connection and Network Service Agreement (CANS 2) for connection assets between the two companies. The PI scheme includes connection asset availability which can be impacted by TasNetworks asset category assets. An overview of Hydro Tasmania PI scheme and performance targets can be found in the SAMP.

6.1.2.2 Tamar Valley Power Station (TVPS)

TasNetworks has a PI scheme in place with TVPS under its Generator Connection Agreement for connection assets between the two companies. The PI scheme includes the connection asset availability measure. An overview of TVPS PI scheme and performance targets can be found in the associated Connection Agreement.

6.1.2.3 Major Industrial Direct Customer Connections

TasNetworks has a number of direct connections to major industrial customers through EHV and Transmission Lines. The following transmission line assets provide these direct connections:

- George Town – Colmalco 220 kV;
- George Town – Temco 110 kV;
- George town – Starwood 110 kV); and
- Burnie Hampshire 110 kV (via Hampshire switching station).

The individual connection agreements describe the level of service and performance obligations required from the associated connection assets.

6.2 Key Performance Indicators

TasNetworks monitors circuit rating and weather monitoring system performance for major faults through its incident reporting process. The process involves the creation of a fault incident record in the event of a major circuit rating and weather monitoring system failure that has an immediate impact on the transmission system. The fault is then subjected to a detailed investigation that establishes the root cause of the failure and recommends remedial strategies to reduce the likelihood of reoccurrence of the failure mode within the circuit rating and weather monitoring system population. Reference to individual fault investigation reports can be found in TasNetworks' Governance, Risk & Compliance System (GRC) (D12/39828).

For circuit rating and weather monitoring system failures that do not initiate a transmission system event, such as minor failure or defects, TasNetworks maintains a defects management system that enables internal performance monitoring and trending of all circuit rating and weather monitoring system related faults or defects.

6.3 Benchmarking

TasNetworks participates in various formal benchmarking forums with the aim to benchmark asset management practices against international and national transmission companies. Key benchmarking forums include:

- International Transmission Operations & Maintenance Study (ITOMS); and

- Australian Energy Regulator (AER) Regulatory Information Notices (RIN).

In addition, TasNetworks works closely with transmission companies in other key industry forums, such as CIGRE (International Council on Large Electric Systems), to compare asset management practices and performance.

6.3.1 External benchmarking

ITOMS provides a means to benchmark performance (maintenance cost & service levels) between related utilities from around the world. For transmission line assets, the benchmarking exercise combines patrol and inspection costs into one category, and maintenance costs in another.

6.4 Service Performance

Power supply failure at some remote sites has temporarily made data unavailable, as well as communications drop-outs have caused reliability issues. Power drop out issues have been addressed recently by a change to lower power equipment.

In particular, the following remedial work has been required across the network:

Table 2 - Monitoring station performance

Weather Station	Tower	Remedial Work
Palmerston	T60 & T66	Intermittent drop-outs fixed by connector repairs made at Palmerston RTU in September 2013
Burnie Substation		Temperature reading fault fixed by replacement temperature transducer in September 2013
Devonport Substation		Ultrasonic wind sensor fault was repaired by replacing connection cable. Fault was caused by water ingress. Repairs made in August 2013
Palmerston	T60, T66 & T103	Communications dropouts caused by failure at Poatina Winch house repeater, repairs made in August 2013
Devonport Substation		Ultrasonic wind sensor fault was repaired by replacing wind sensor. Repairs made in June 2012
Farrell Substation		Temperature sensor values had intermittent spikes. Fault was caused by water ingress to cable connector. Repairs made in June 2012
Gordon–Chapel Street 220 kV	T130	Power supply fault caused by water ingress to solar supply cables. Repairs made in June 2012.
Gordon–Chapel Street 220 kV	T130 & T133	Intermittent communications fault was repaired in December 2011
Sheffield Substation		Temperature reading fault was repaired by replacing cable (fault with plug connector). Repairs were made in July 2011

7 Associated risk

TasNetworks has adopted the risk management principles detailed in Australian Standard AS/NZS ISO 31000:2009 'Risk management – principles and guidelines' in managing risks associated with its transmission line circuit rating and weather monitoring assets. The primary goals of the risk management strategy are to:

- ensure the safety of personnel and the public as far as practicable; and
- manage the impact of defective assets on transmission system performance.

7.1 Risk Management Framework

TasNetworks has developed a Risk Management Framework for the purposes of

- Demonstrating the commitment and approach to the management of risk – how it is integrated with existing business practices and processes and ensure risk management is not viewed or practiced as an isolated activity;
- Setting a consistent and structured approach for the management of all types of risk; and
- Providing an overview on how to apply the risk management process.

Assessment of the risks associated with the transmission line support structure foundations has been undertaken in accordance with the Risk Management Framework. The risk assessment involves:

- Identification of the individual risks including how and when they might occur
- Risk analysis of the effectiveness of the existing controls, the potential consequences from the risk event and the likelihood of these consequences occurring to arrive at the overall level of risk.
- Risk evaluation where risks are prioritised based on their ratings and whether the risk can be treated) or managed at the current level.
- The likelihood and consequence of risk events occurred are assessed using the following risk rating matrix in Figure 1:

Figure 1: Risk Ranking Matrix

LIKELIHOOD		CONSEQUENCE				
		1 NEGLIGIBLE	2 MINOR	3 MODERATE	4 MAJOR	5 SEVERE
• ≥ 99% probability • Impact occurring now • Could occur within "days to weeks"	5 ALMOST CERTAIN	MEDIUM	MEDIUM	HIGH	VERY HIGH	VERY HIGH
• 50% - 98% probability • Balance of probability will occur • Could occur within "weeks to months"	4 LIKELY	LOW	MEDIUM	HIGH	HIGH	VERY HIGH
• 20% - 49% probability • May occur shortly but a distinct probability it won't • Could occur within "months to years"	3 POSSIBLE	LOW	LOW	MEDIUM	HIGH	HIGH
• 1% - 19% probability • May occur but not anticipated • Could occur in "years to decades"	2 UNLIKELY	LOW	LOW	MEDIUM	MEDIUM	HIGH
• ≤1% probability • Occurrence requires exceptional circumstances • Only occur as a "100 year event"	1 RARE	LOW	LOW	LOW	MEDIUM	MEDIUM

The Risk Management Framework requires that each risk event is assessed against all of the following consequence categories:

- Safety and People
- Financial
- Customer
- Regulatory Compliance
- Network Performance
- Reputation
- Environment and Community

This asset management plan describes the major risks associated with transmission line circuit rating and weather monitoring systems and the current or proposed treatment plans.

7.2 Risk Identification

Circuit rating and weather monitoring systems are strategic assets which are integral to the operation of the transmission system.

The circuit rating and weather monitoring systems consist of a software program relying on information from databases, tension monitors, weather stations and communication links.

The following key risks (failure mechanisms) are evident:

- data integrity from weather stations and within the TRCalc database;
- communication and power supplies; and
- software and design components.
- In summary, these failures may result in increased risk by compromising:
- the maximisation of transmission network capability, resulting in generation constraints;
- the protection of transmission circuits against loads that would cause the conductors' design temperature to be exceeded resulting in substandard conductor ground clearances; and
- the protection of conductors against overheating and consequential loss of strength and eventual failure.

7.3 Summary of risk

Table 3 summarises the transmission line support structure foundations risks, their mitigation strategy and residual risk levels.

7.4 Monitoring and review

The management strategies adopted to mitigate the risks associated with rating and weather monitoring system assets are monitored on an ongoing basis to ensure they are effective and relevant to achieving TasNetworks' risk management objectives.

TasNetworks also participates in the International Transmission Operations and Maintenance Survey (ITOMS), an acknowledged benchmarking process tailored to the electricity industry. TasNetworks' participation in ITOMS not only serves as a means of benchmarking its assets performance against like electrical utilities, but also enables Tasnetworks to learn, share and adopt best practices, thereby reinforcing and embracing a culture of continuous improvement.

Risk assessments are reviewed and where the risk level has been evaluated to have changed, a review based on a monitoring and evaluation program may initiate changes to the asset management plan strategies.

Table 3 - Transmission line circuit rating and weather monitoring system risk analysis

RISK IDENTIFICATION		RISK ANALYSIS				RISK MITIGATION	
Risk	**Detailed Risk**	**Category**	**Likelihood**	**Consequence**	**Risk Rank**	**Mitigating Action(s)**	**Residual Risk Rating**
Collection of incorrect data resulting in circuit overload and sub-standard conductor to ground clearances.	Provision of incorrect information from remote stations may cause overloading of transmission circuits and operate the conductor above its design temperature. This may result in sub-standard conductor to ground clearances, increasing the risk to field crews and the public.	Safety and People	Rare	Severe	Medium	• Bi-annual calibration, servicing and fault rectification of the circuit rating and weather monitoring systems and associated communication links. • Utilisation of backup weather stations for the provision of critical data.	Medium
		Financial	Unlikely	Minor	Low		Low
		Customer	Unlikely	Minor	Low		Low
		Regulatory Compliance	Unlikely	Minor	Low		Low
		Network Performance	Unlikely	Minor	Low		Low
		Reputation	Unlikely	Minor	Low		Low
		Environment & Community	Rare	Severe	Medium		Medium
Poor data integrity (network configuration) in TRCalc causing incorrect ratings resulting in conductor overheating, loss of strength, and eventual failure.	Incorrect information may cause overloading of transmission circuits and operate the conductor above its design temperature for sustained periods and result in annealing and loss of mechanical strength and eventual failure.	Safety and People	Rare	Severe	Medium	Manually update TRCalc in accordance with: • maintenance procedure for TRCalc D06/18855 • reasonability Limits standard D05/52104; • release notes for recent updates of TRCalc; and • test documentation.	Medium
		Financial	Unlikely	Minor	Low		Low
		Customer	Unlikely	Minor	Low		Low
		Regulatory Compliance	Unlikely	Minor	Low		Low
		Network Performance	Unlikely	Minor	Low		Low
		Reputation	Unlikely	Minor	Low		Low
		Environment & Community	Rare	Severe	Medium		Medium
Encroachments	Weather based operating calculations assume that minimum conductor clearance has been maintained. Unauthorised structures etc in the transmission easement results in transmission line fault, outage and/or injury or death.	Safety and People	Rare	Severe	Medium	Ensure unauthorised encroachments in easements are identified in inspections and appropriate actions are completed in the specified timeframes. Ensure NOCS are aware of any encroachments which limit the operation of transmission lines.	Medium
		Financial	Unlikely	Minor	Low		Low
		Customer	Unlikely	Minor	Low		Low
		Regulatory Compliance	Unlikely	Minor	Low		Low
		Network Performance	Unlikely	Moderate	Low		Low
		Reputation	Unlikely	Minor	Low		Low
		Environment & Community	Rare	Severe	Medium		Medium

8 Management plan

8.1 Issues summary

The following section highlights technical issues regarding TasNetworks' population of circuit rating and weather monitoring systems.

8.1.1 Obsolescence

A number of weather stations were previously owned by Hydro Tasmania. Ownership was transferred to TasNetworks in 2005. The circuit rating and weather monitoring equipment at the monitoring stations has evolved over more than 10 years with upgrades to improve data quality and availability. Most of the stations are located in remote areas with difficult access. Over the years a wide variety of components have been used, some of which were custom designed and manufactured to suit specific needs. As a result, we do not hold spares for these components. As discussed above, wherever faulty custom or obsolete components are identified they will be replaced with the latest commercially available parts where possible.

8.1.2 Weather station site location

Some weather stations are located inside the substation perimeter, preventing unaccompanied access by TasNetworks' service provider when undertaking calibration, testing and fault response activities. This introduces an additional time and cost impost on these activities due to the requirement to secure the services of an Aurora Services EHV Substation Operator to provide access to these sites. To remedy this, TasNetworks is implementing a progressive upgrade program, whereby weather stations are relocated to a secure site outside the substation, similar to that recently implemented at George Town Substation (tower T242). Weather stations at which this relocation is necessary include:

- Burnie;
- Creek Road; and
- Chapel Street.

8.1.3 Weather station equipment location

The sensors at Chapel Street, Creek Rd, Trevallyn, Burnie and Devonport monitoring stations are located in such a way that they do not meet the recommended criteria specified by the Bureau of Meteorology . This results in the provision of data that is not indicative of atmospheric conditions at the transmission line level. Instead, they only provide data that is indicative of the weather conditions at ground level, which can differ significantly from that at the transmission line level. Where possible, algorithms have been developed to correct for this difference within TasNetworks' dynamic ratings system, however the errors inherent in such an approach make this a non-preferred solution. TasNetworks is currently implementing an upgrade program whereby sensors at these locations are raised to a more suitable location that will ensure atmospheric conditions are recorded with greater accuracy.

8.1.4 Wind speed measurement

In the last five years TasNetworks has implemented an upgrade program that has resulted in the replacement of mechanical cup-type anemometers with ultrasonic anemometers. This program arose as a result of a drop in anemometer performance over time due to condition deterioration, and also due to these mechanical anemometers being insufficiently sensitive to measure wind speeds slower than 0.5m/s.

The new ultrasonic anemometers have proven to be reliable and effective, and will remain the standard design for new weather stations.

8.1.5 Signal processing and communication

TasNetworks has previously utilised DirectLogic PLCs at all its remote sites for the analogue-to-digital conversion of weather station input signals, and subsequent retransmission of this data. These PLCs have a design life of approximately 15 years and have been in service for between 10 and 15 years. The PLCs have also been found to have excessive power consumption, resulting in battery failures at those sites where solar power is the primary power supply.

A more suitable device that has been demonstrated (at the GO-CS T130 de-icing station) to consume significantly less power is the Campbell Logger.

All new weather stations utilise Campbell Loggers, and TasNetworks is currently implementing an upgrade program whereby old PLCs that are at end of life are replaced with Campbell Loggers. This will both reduce power consumption (and hence improve weather station reliability), and will manage TasNetworks' fleet of PLCs that are deemed to be at the end of their technical life.

8.1.6 Power supplies

All weather stations located within or adjacent to a substation utilise mains supply from that substation. It is TasNetworks' preference that power supplies for these sites should be sourced from an independent solar supply, physically disconnecting the weather stations from the substation, reducing the reliance upon substation or communications personnel when responding to faults, and also removing the mains cable as a potential point of failure. Sites identified for upgrade to achieve this include:

- Burnie;
- Creek Road;
- Chapel Street;
- Devonport;
- Trevallyn;
- Hadspen;
- Sheffield; and
- Farrell.

Weather stations located on transmission towers in remote sites use solar power as their predominant source of energy. While this has been found to be adequate in almost all locations, to supplement the main solar supply (which can be inadequate during prolonged overcast days), one site also utilises a wind generator. Any new weather station sites will be assessed to ensure that primary and backup power supplies are adequate to their location.

At the de-icing tension monitoring station, a communication upgrade resulted in assets being installed with a higher power demand. The existing solar power supply, although adequate during days of full sun to maintain the batteries, was found to be inadequate during prolonged overcast

days. The addition of a methanol fuel cell battery charger to supplement the solar cells was required to supply the increased power demand.

The power supply for the weather station located at Farrell Substation is supplied from a general power outlet (GPO) located on the substation wall. This is an unacceptable arrangement as it has resulted in the weather station power supply being inadvertently disconnected or switched off by other service providers undertaking work within the substation building. TasNetworks has programmed the upgrade of the power supply from mains to solar, providing physical isolation of the weather station from the substation power supply and removing the risk of inadvertent disconnection of supply.

8.1.7 Local communications

When weather stations are located inside a substation, communications between the weather station and the RTU normally consist of a copper wire.

In remote locations TasNetworks has found that radio modems (Elpro) are reliable and effective in relaying information to the nearest base station or substation.

It is TasNetworks' preference to move towards a weather station design that is physically independent of substation infrastructure, as this reduces the reliance upon substation or communications personnel when responding to faults, and it also removes the copper wire as a potential point of failure. Whenever a weather station is moved to a location outside the substation it is TasNetworks' preference to also install radio modems to provide communications with the substation RTU, while also facilitating removal of the hardwired copper connection.

8.1.8 Response to Circuit Rating and Weather Monitoring System Issues

The capital plan for the 2014-19 period has been developed taking into account the issues raised above.

8.2 Maintenance strategy

The good performance of circuit rating and weather monitoring system's is achieved through the implementation of regular preventive and corrective maintenance activities. Preventive and corrective maintenance practices are reviewed on a regular basis taking into account:

- past performance;
- industry practice (derived from participation in technical forums, benchmarking exercises and discussions with other transmission companies); and
- the availability of new technologies.

Table 4 provides a summary of the maintenance strategies for circuit rating and weather monitoring station assets.

Table 4 -Transmission line conductor assembly management strategies

Asset	Frequency	Strategy
Circuit rating and weather monitoring assets and associated communication links.	Six monthly	Utilise recognised external service providers for the calibration, servicing and fault rectification of circuit rating and weather monitoring systems and associated communication links.

TasNetworks utilises a recognised external service provider for the provision of maintenance services for circuit rating and weather monitoring assets. Details of the routine maintenance activities for weather monitoring and tension monitors are contained in TasNetworks' contract with the service provider.

TasNetworks maintain TRCalc and other internal software tools that provide ratings information.

8.2.1 Preventive maintenance

Preventive maintenance is, by its nature, a planned and scheduled maintenance activity that is completed to a predetermined scope, and consists of:

- Condition assessment - the routine inspection, testing and monitoring of assets to ascertain their condition.
- Maintenance (routine and condition based) - assets are maintained either on predetermined frequency basis (time-based) or in response to findings arising from condition assessment activities.

8.2.2 Corrective Maintenance

In the event of a fault condition TasNetworks will arrange for corrective maintenance to occur to either replace the asset, or to undertake other activities to restore the asset to an appropriate level of service.

8.2.3 Technical support

Other operational costs which are not able to be classified under the above categories are allocated to technical support. These tasks include:

- system fault analysis and investigation;
- preparation of asset management plans;
- standards management;
- management of the service providers;
- training;
- group management; and
- general technical advice.

8.3 Capital plan

TasNetworks' circuit rating and weather monitoring system capital investment strategy has been developed taking into consideration the design related issues, condition, performance issues and risks associated with the population of assets.

Incorporating the issues identified, Table 5 provides a summary of the various upgrades currently programmed across the weather station population.

Table 5 - Weather station upgrade program

SITE	Planned Replacement
Burnie Substation	2029/30
Chapel Street Substation	2031/32
Creek Road Substation	2030/31
Devonport Substation	2032/33
Farrell Substation	2018/19
TL516 GO-CS Tower T130 220kV (de-icing stn)	2026/27
TL516 GO-CS Tower T133 220kV	2026/27
Hadspen Substation Tower T151A	2032/33
TL500 LI-CS Tower T16 220kV	2029/30
TL500 LI-CS Tower T102 220kV	2026/27
TL509 PM-GT Tower T242 220kV	2026/27
TL509 PM-GT Tower T60 220kV	2026/27
TL413 PM-TR Tower T119 110kV	2026/27
TL503 PM-SH Tower T66 220kV	2026/27
Sheffield Substation	2018/19
Trevallyn Substation	2018/19
TL426 TU-WA Tower T130 110kV	2026/27

8.4 Disposal plan

All circuit rating and weather monitoring assets are sold to scrap after removal.

8.5 Spares Management

Obsolescence of circuit rating and weather monitoring system assets is an issue for TasNetworks. Due to the development of these systems, spares are not held for these components. Where faulty custom or obsolete components are identified they will be replaced with the latest commercially available parts where possible.

8.6 Technology and innovation

TasNetworks recognises that a proactive approach to lifecycle management of its assets is an established and accepted practice within the electrical industry. Low wattage equipment has been

installed in recent years as a response to an increase in outages due to power supply issues. Removing weather stations from operational areas of substations has also been identified as it reduces the on-going operational expenses associated with access requirements.

9 Financial summary

9.1 Operational expenditure

Requirements for operating expenditure are a function of the defined periodic condition monitoring regimes, defined maintenance requirements and expected minor and major conductor assembly works.

The developed works plan is held and maintained in the works planning tool. It contains details such as planning dates, task types, specific assets and planned costs.

The planned costs for each differing task type are derived from either unit rates from Contractors or averaged historical costs.

9.2 Capital expenditure

Transmission line circuit rating and weather monitoring system capital works are typically combined with other works to optimise system performance and mitigate network and business risk.

The projected capital expenditure required to implement the support structure foundation capital program is subject to change and optimisation as the integrated works plan is refined and further developed.

Each project within the program is then subjected to a detailed investment evaluation.

9.3 Investment evaluation

For each program or project to be included within the upcoming revenue proposal, an Investment Evaluation Summary (IES) is prepared describing the condition, performance and risk issues identified within this and other asset management plans.

The IES then identifies a preferred option using cost estimates that have been developed in line with TasNetworks' estimation process. Each option is evaluated on both technical and financial merits and the preferred option is submitted for regulatory approval.

The Investment Evaluation Summaries associated with the current 2014–2019 capital program and proposed 2019-2024 capital program for transmission line circuit rating and weather monitoring system are listed in Appendix A.

10 Related standards and documentation

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

WASP Asset Register – Data Integrity Standard – Wind Monitor	R17103
WASP Asset Register – Data Integrity Standard – Solar Monitor	R17105
WASP Asset Register – Data Integrity Standard – Temperature Monitor	R17032
WASP Asset Register – Data Integrity Standard – Tension Monitor	R17085
WASP Asset Register – Data Integrity Standard – Weather Station	R17102
Transmission line design standard	D05/12858
Transmission line weather stations and tension monitoring station standard	D05/47944
Gordon–Chapel Street 1 and 2 transmission line snow and ice loading procedure (TNO-012)	R424709
Line rating data failure–managing dependant applications and resolution of physical problem (TNO-057)	R428911

Appendix A Investment Evaluation Summaries

The following Investment Evaluation Summary (IES) documents relate to transmission line support structure foundations.

Reference	Name	Expenditure Type	Regulatory Period
R479120	Weather Station Telemetry Renewal Program Investment Evaluation Summary	CAPEX	2014-2019