Asset Management Plan

AC Distribution Systems

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Authorisations

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Review cycle	2.5 Years	

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.

Please contact the Asset Strategy Leader with any queries or suggestions.

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

Record of revisions

Section number	Details
All sections	*Re-write from Transend format into TasNetworks format and update of data.*

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1 Purpose

The purpose of this asset management plan is to define the management strategy relating specifically to AC distribution systems and related assets. The plan provides:

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

2 Scope

This asset management plan covers all AC distribution systems within TasNetworks owned substations and switching stations for a ten year rolling planning period. The objective of this plan is to maintain and minimise business risk to acceptable levels by achieving reliable asset performance at minimal life-cycle cost.

3 Strategic Alignment and Objectives

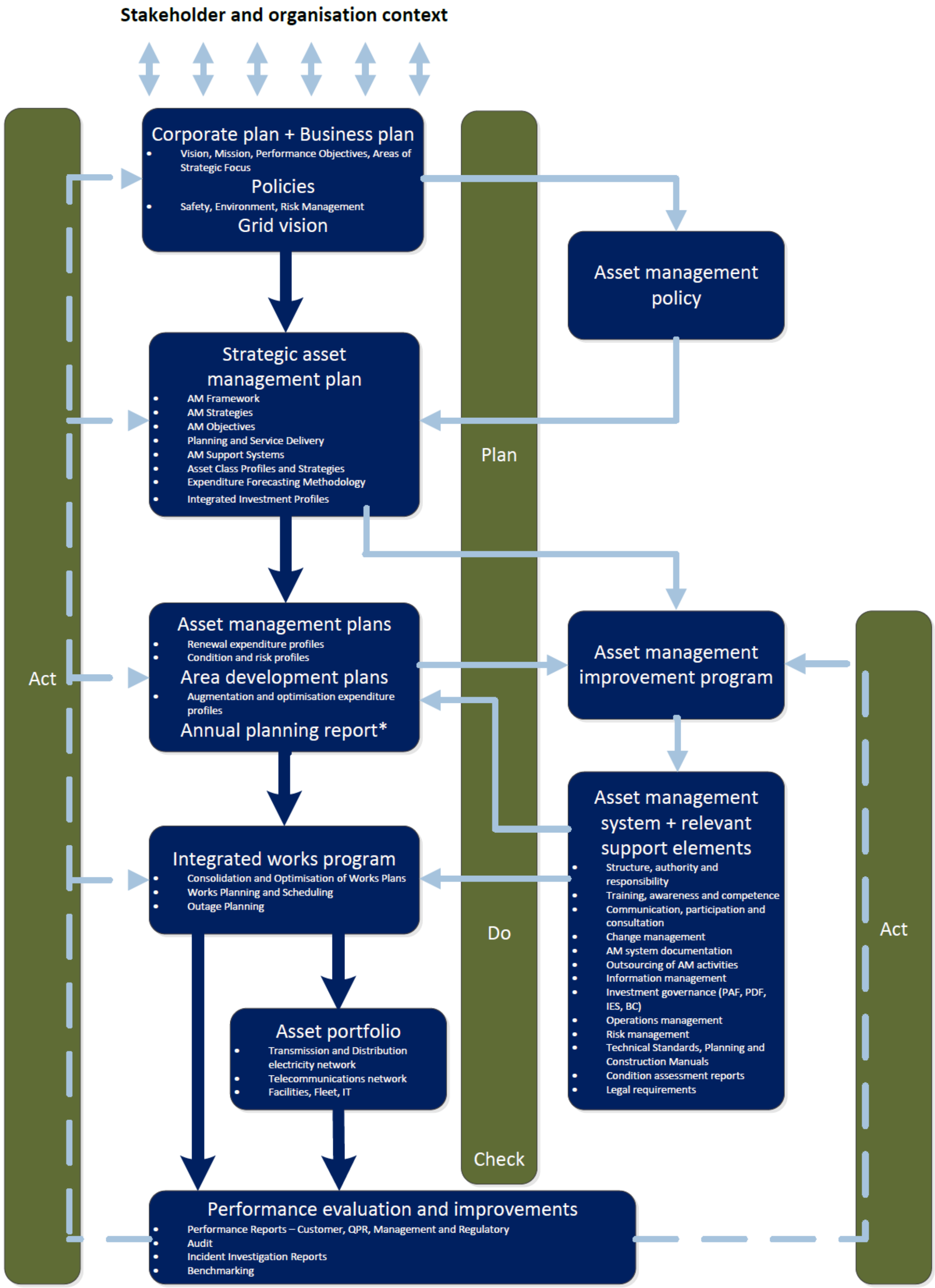
This asset management plan has been developed to align with both TasNetworks' Asset Management Policy and Strategic Objectives. This management plan describes the asset management strategies and programs developed to manage the AC distribution systems, with the aim of achieving these objectives.

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.

The asset management policy and strategic objectives are outlined within the Strategic Asset Management Plan. Figure 1, from the Strategic Asset Management Plan, 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 Annual Planning Report (APR) is a requirement of sections 5.12.2 and 5.13.2 of the National Electricity Rules (NER) and also satisfies a licence obligation to publish a Tasmanian Annual Planning Statement (TAPS). The APR is a compilation of information from the Area Development Plans and the Asset Management Plans.

4 Asset Information Systems

4.1 Systems

TasNetworks maintains an asset management information system (AMIS) that contains detailed information relating to substation assets. 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.

It is a tool that interlinks asset management processes through the entire asset life-cycle and provides a robust platform for extraction of relevant asset information.

Asset defects are recorded directly against the asset registered in the asset management information system (WASP).

The defect information is readily accessible through TasNetworks' business intelligence reporting system

It is noted that a new Asset Management system (SAP) will be commissioned early in 2018 to replace WASP.

4.2 Asset Information

Currently, AMIS only contains information on Station Service Transformers which are one component of the AC system. No information is available on the condition or configuration of other equipment, such as distribution boards and connected devices, associated with the AC systems.

The following AMIS standard provides information requirements relevant to Station Service transformers:

- R17081 WASP Asset Register, Data Integrity Standard – Station Service Transformer

4.2.1 AM8 Condition data

An initiative within the Asset Performance and Strategy team was completed in 2016 to review key asset condition and maintenance regimes to assess their capability for asset condition being the basis for setting spending priorities. This initiative was referred to as AM8.

Condition based assessments provide a quantitative means to assess asset condition, their risk and failure probabilities and a basis to justify mitigation measures. Condition assessments are used to produce risk indices for assets and / or asset classes and provide a basis for asset expenditures.

Condition data is gathered through asset inspection and maintenance activities and is used along with defect, failure and performance data to formulate asset management strategies. Condition assessment relies on asset knowledge capable of being modelled using numerical analysis.

A number of observations were concluded as part of the review including the need to obtain condition data consistently across all asset types and in electronic form. The need for storage and collection would align with other business initiatives such as the AJILIS project.

5 Description of the Assets

Alternating current (AC) distribution systems are installed at substations (and other sites) to provide electrical supply at 400 V and 230 V. AC supplies are required primarily to supply power to:

- DC battery chargers;
- Transformer tap-changer motors and other equipment;
- Transformer tap-changer control;
- Substation general climate control, light and power;
- Compressed air systems; and
- Other low voltage AC loads within the substation.

In the event of a loss of AC supply for an extended duration, the battery banks will discharge to the point they can no longer provide critical DC supply. To enable the batteries to be charged in the event of a prolonged AC outage, generator inlet connection points have been fitted to the exterior of substation buildings to enable TasNetworks' mobile generator to connect and supply AC power.

To mitigate the risk posed by exposed terminals and inadequate clearance between panels TasNetworks, in its 'AC Distribution System Standard' (D01/7205) has specified that all future AC distribution boards must have an enclosure with a degree of protection equivalent to IP3X rating

5.1 Shared Supplies

Adequate levels of reliability and availability of the AC distribution systems are required, commensurate with the type of service, including for those sites where TasNetworks has substantial primary substation asset ownership.

TasNetworks relies on third party AC supplies at several sites either due to shared site arrangements from Hydro Tasmania disaggregation or due to non-availability of distribution voltages in the switchyard. These are mainly substations close to power stations.

Refer to Table 1 for a list of sites where station supply is provided by or shared with a third party.

Table 2 lists all sites that do not require a station supply. In summary, there are 3sites which do not require a station supply, 3 sites where supply is provided by Hydro Tasmania or some other party.

Table 1: Sites where AC station supply is provided by or shared with a third party

	Station Name	Voltage	Station Supply	Comments
Switching Stations				
1	Hampshire	110 kV	Customer	T configuration with CBs and disconnectors. (Shared site with Gunns Hampshire mill).
3	Wayatinah Tee	220 kV	Hydro	Distribution LV Feeder from Wayatinah PS
Substations				
4	Gordon	220/22 kV	Hydro	Shared site with Hydro. Transformer T6 (220/22

	Station Name	Voltage	Station Supply	Comments
				kV) is TasNetworks owned, but station service transformers belong to Hydro

Table 2: Sites where a station AC supply is not required

	Station Name	Voltage	Station Type	Comments
1	George Town	110 kV	Transition Station	110 kV connection to Starwood from George Town Substation via TL470
2	Butlers Gorge Tee	110 kV	Switching Station	Only a T structure with one disconnector on Derwent Bridge arm.
4	Waratah Tee	110 kV	Switching Station	Only a T structure with a disconnector on each arm

5.2 AC Distribution System Types

For the purpose of this asset management plan, AC distribution systems are categorised into three types based on their compliance with the present TasNetworks AC Distribution System Standard and to AS 3000. The categories include;

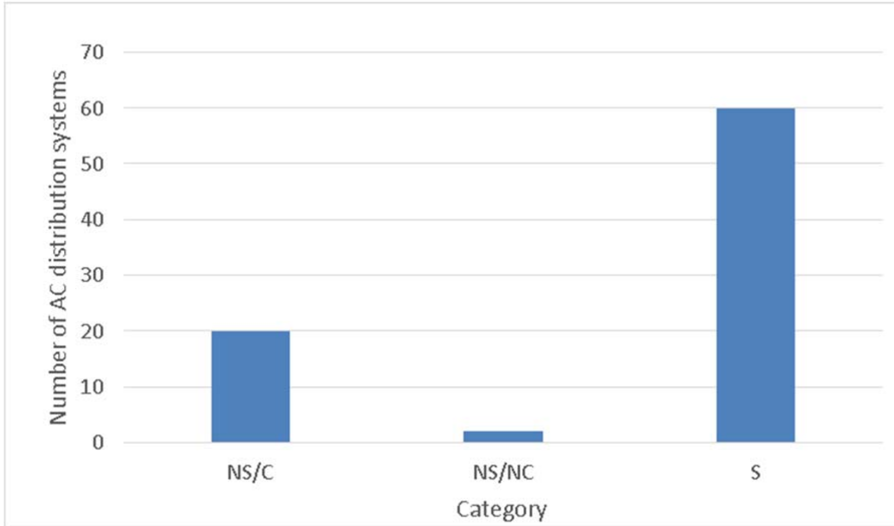
- S – TasNetworks Standard type - newly installed systems in conformance with D01/7205;
- NS/C – non-standard but compliant to AS 3000 – fully enclosed panels; and
- NS/NC – non-standard and non-compliant to AS 3000 - those having exposed terminals at the back of panels.

Figure 2 details the number of AC distribution boards in each category.

TasNetworks' population of AC distribution systems contain various panel configurations. They house different types of switchgear and arranged in different configurations. Currently, AMIS only contains information on Station Service Transformers of the AC distribution systems. No information is available on the condition or configuration of other equipment associated with these systems.

Appendix C- Details of AC Distribution Systems in Substations and Switching Stations provides a summary of AC distribution systems categorised based on the above three types.

Figure 2: Number of AC distribution systems by category (as at May 2017)

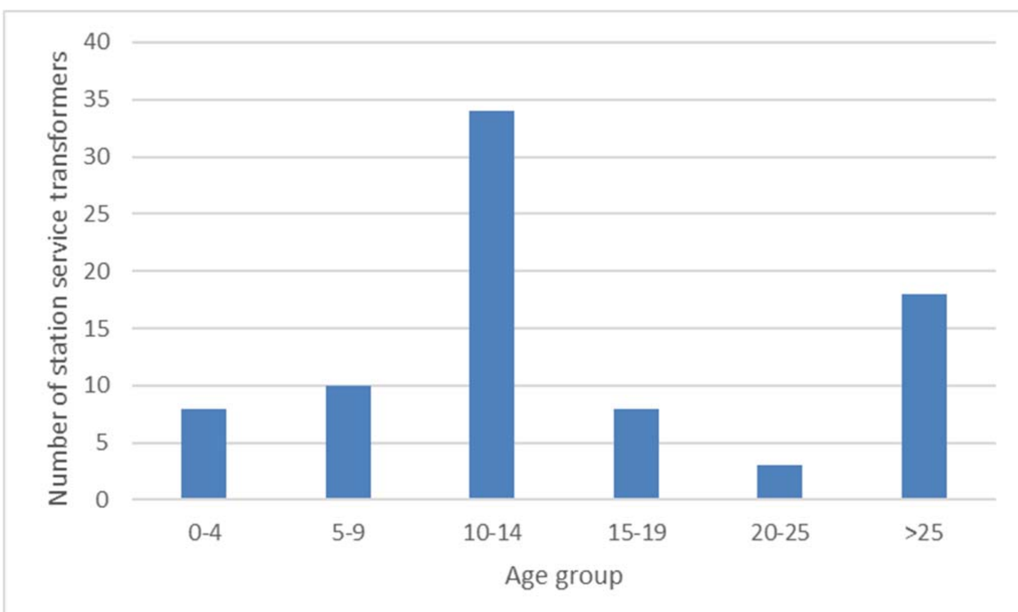


5.3 Total Population by Age

Documented age information is available only on the station service transformers (SSTs), although it could be reasonably assumed in most cases that the age of SST reflects the age of the AC system as well.

Station service transformers are expected to have an average service life of 45 years corresponding to their economic life. The average age of TasNetworks' existing station transformer population is around 16 years while 22 per cent of the transformers are less than 10 years old and only 22 per cent are over 25 years old. (Refer Figure 3 for the age profile of the SST population). There is only one transformer in the system which is over 45 years old and two transformer will reach there expected service life within the next 5 years.

Figure 3: Station service transformer age profile (as at May 2017)



6 Standard of Service

6.1 Technical Standards

To address potential design issues, TasNetworks has developed a comprehensive, prescriptive standard specification for the design and procurement of AC distribution systems. The specification requires units to be designed and type-tested to Australian and international standards. The prescriptive technical specification enables standardisation of AC system design which also starts to address the population type issues.

Technical requirements for new AC distribution systems are detailed in TasNetworks' AC Distribution System Standard.

6.2 Performance Objectives

To mitigate the risk of inadequate quality control during manufacturing, TasNetworks requires AC distribution system manufacturers to have AS/NZ ISO 9001 accreditation and conform to its requirements TasNetworks also requires routine tests to be performed on each component of the AC distribution system to prove the quality of manufacture prior to dispatch from the manufacturer's works.

In order to ensure that AC distribution system faults do not arise from poor installation, assembly or repair of a unit, TasNetworks ensures that supplier and service providers are suitably qualified and experienced.

6.3 Key Performance Indicators

TasNetworks undertakes two broad classes of performance monitoring, namely internal and external performance monitoring.

6.3.1 Internal Performance Monitoring

TasNetworks monitors AC distribution systems internal performance for faults through its incident reporting process. The process involves the creation of a fault incident record in the event of a major AC distribution system failure that has an impact on, or has the potential to impact on the transmission system. The fault incident 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 AC distribution systems population. Reference to individual fault investigation reports can be found in TasNetworks' Reliability Incident Management System (RIMSys).

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

The AC distribution systems performance impacts on TasNetworks' overall network service obligations, which include specific performance requirements for both prescribed and non-prescribed transmission assets

TasNetworks' service target and performance incentive (STPIs) scheme, which has been produced in accordance with the Australian Energy Regulator's (AER's) Service Standards Guideline, is based on plant and supply availability. The PI scheme includes the following specific measures:

- Plant availability:

  - o Transmission line circuit availability (critical and non-critical); and
  - o Transformer circuit availability.
- Supply availability:
  - o Number of events in which loss of supply exceeds 0.1 system minute; and
  - o Number of events in which loss of supply exceeds 1.0 system minute.

Details of the STPIS scheme and performance targets can be found in TasNetworks' Strategic Asset Management Plan.(SAMP).

The availability of AC distribution systems has an impact on the performance measures reported regularly to the AER and directly impacts on TasNetworks' performance incentive scheme.

TasNetworks has evaluated its AC distribution systems performance against external benchmarks, such as International Transmission Operations & Maintenance Study (ITOMS), and the various performance incentive schemes which measure availability and loss of supply events.

6.3.2 External Performance Monitoring

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

- International Transmission Operations & Maintenance Study (ITOMS); and
- Australian and New Zealand chief executive officer's benchmarking forum, which provides information to the Energy Supply Association of Australia (ESAA) for its annual industry performance report.

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.

6.3.2.1 ITOMS Benchmarking

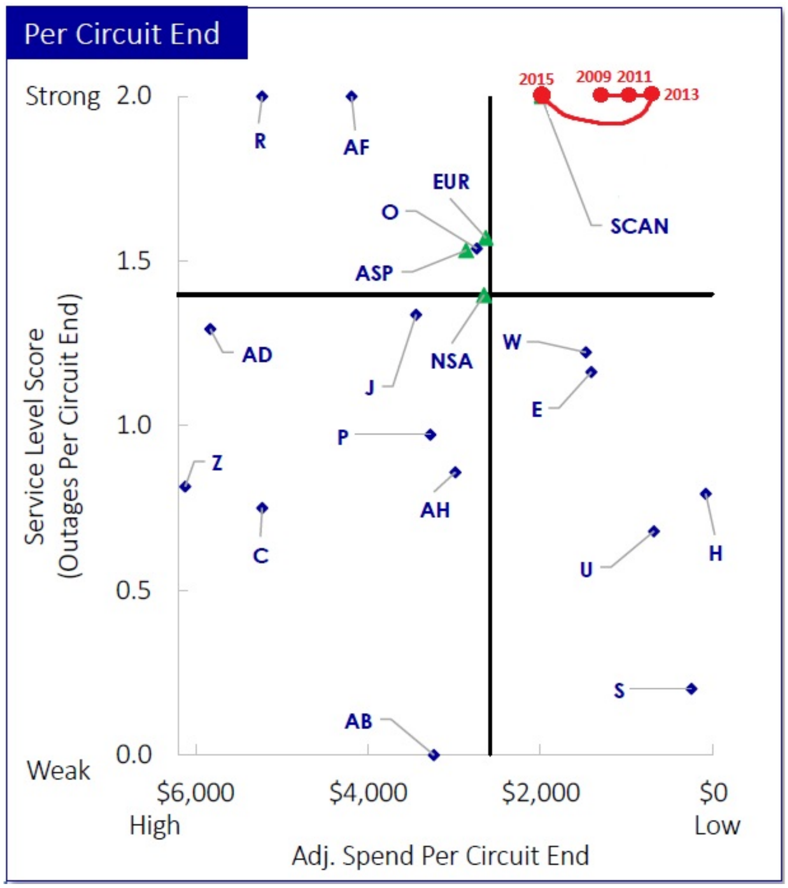
The industry benchmarking of AC distribution system assets are not covered as a specific category measure in ITOMS activities but they are covered within the auxiliary systems assets combining both AC and DC systems collectively called auxiliary plant equipment. Further discussions relating to the ITOMS studies are presented in relevant ITOMS reports which are held by TasNetworks Network Performance and Asset Strategy group.

The ITOMS results are typically presented in a scatter plot which enables comparison between participant utilities. The international benchmarked averages (cost & service) are shown as the centre crosshairs, with diamond shapes representative of surveyed participant utilities and regional averages shown as triangles marked NA (North America), EUR (Europe), ASP (Australia South Pacific), and SCAN (Scandinavia). The optimal performance location on the scatter plot is located in the upper right hand quadrant because, in this quadrant, service level is at its highest at the least cost. For AC distribution system assets, TasNetworks have been consistently in this upper right hand quadrant and this has continued for 2015. The chart does demonstrate that the average spend has increased with service level score remaining at the maximum high level.

Figure 4 illustrates that the performance, in terms of maintenance expenditure and fault outages of TasNetworks' auxiliary equipment, has maintained low service costs and high service performance consistently across years 2009 to 2015 when compared to other transmission companies in the study.

The external benchmarking activities demonstrate that the performance of TasNetworks' auxiliary systems is favourably aligned to that of other participants in the ITOMS study, as shown in figure 4. For auxiliary plant equipment, TasNetworks is consistently in the upper right hand quadrant as shown in figure 4 as red circles. Maintenance costs are being maintained at relatively low levels for a correspondingly high service level. The present maintenance strategies should be continued in order to maintain high levels of reliability and performance. The replacement of obsolete AC distribution systems where failing condition and safety issues are some of the drivers that contributes to poor performance statistics. Further improvements are expected through a proactive approach of failure prevention, key performance indicators and on-line monitoring.

Figure 4: ITOMS Auxiliary Plant benchmarked performance chart



6.3.2.2 ESAA Benchmarking

TasNetworks' reporting to the ESAA covers transmission network data of system minutes unsupplied, energy delivered and transmission circuit availability. For ESAA benchmarking, network data is limited to transmission circuits.

6.3.2.3 Failure Types

An ongoing upgrade program usually incorporated into substation redevelopments, is in place and will address the identified issues on a case by case basis. TasNetworks circuit breaker replacement program has also reduced the criticality of AC supplies at many sites, by employing circuit breakers that do not rely on compressed air systems for their operation.

The reliance on third party AC supply systems needs review, with adequate agreements put in place. Where satisfactory agreements cannot be put in place and the risk is considered unacceptable, new TasNetworks-owned AC supply systems may be installed.

Applications of Station Service Power Voltage Transformers (SSPVTs) are becoming increasingly popular at remote sites where load is low and no distribution feeder is available or too expensive to bring one in. Directly tapped from the transmission line, SSPVT transforms transmission voltage (input) down to low voltage (output). TasNetworks has recently commissioned two SSPVTs, at Farrell Substation and Castle Forbes bay Tee locations.

TasNetworks has adopted an AC distribution system standard to ensure a consistent approach to address issues associated with AC distribution systems. TasNetworks present policy is to install indoor dry-type air-insulated station supply transformers and enclosures with IP3X rating in future installations. At present, there are 21 oil insulated and 58 cast-resin dry-type station service transformers in the network. See Appendix A for additional details on station supply transformers at all substations.

7 Associated Risk

7.1 Risk Management Framework

TasNetworks has developed a Risk Management Framework for the purposes of assessing and managing its business risks, and for ensuring a consistent and structured approach for the management of risk is applied.

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

An assessment of the risks associated with the AC distribution system has been undertaken in accordance with the Risk Management Framework. For each asset in this class the assessments have been made based on:

- Condition of AC distribution system in service across the network
- Criticality of AC distribution system and associated assets
- Probability of failure (not meeting business requirement)
- Consequence of failure
- Performance
- Safety risk
- Environmental risk
- Customer

Due to the level of risk identified in some of the assessment criteria a requirement to actively manage these risks has been identified.

7.1.1 Condition

The condition assessment and maintenance practices for substation AC distribution systems have been revised where appropriate to sustain or improve substation AC distribution system reliability. Such maintenance practices together with industry benchmarking activities are aimed at reinforcing and implementing a regime of continual improvement, innovation and learning. The adoption of contemporary asset management techniques are aimed at reducing the substation AC distribution system annual preventive maintenance expenditure.

Most of the components in the AC distribution system are low maintenance equipment. Therefore there is no need to have routine condition assessments on AC distribution systems. Usually, a visual inspection of the system is carried out during the routine site inspection and protection systems such as fuses are replaced when required.

The issues with the current population of AC distribution systems are as follows:

- Non-compliance with AS3000;
- AC distribution board is obsolete;
- Asbestos within distribution boards; and
- Inadequate neutral earthing.

TasNetworks has been progressively replacing the AC systems which are aged or not complying with the current occupational health and safety regulations. These replacements are usually incorporated into larger substation redevelopments.

7.1.2 Probability of Failure

It has been identified that there is an increased probability of supply failure where the supply is taken from a third party or is supplied from a rural distribution network. This is due to reliance on the third party to ensure their assets are well maintained and also considerate of environmental factors, ie. weather events and vegetation management. This is only applicable for a few substations as noted in Appendix B – Details of Station Service Transformers in Substations.

The combination of enhanced design capability, improved manufacturing quality and control processes, and comprehensive production testing usually ensures that performance levels of new AC distribution systems remain high throughout their service lives.

7.1.3 Consequence of Failure

Since the AC distribution system supplies and maintains the DC system, failure of AC distribution system has been identified as a key risk because it has the potential to impact on safety and transmission system performance. TasNetworks does not currently have an accurate record of past failure or defect rates for its population of station transformers and/or distribution boards. Processes are currently being implemented to accurately capture future events.

In addition the failure of AC system will impact on general station light and power and transformer tap changer operation.

An incident occurred at Sheffield Substation in 2006 where fault recorders failed to record data during an incident due to low DC voltage. This was caused by batteries not holding charge long enough as designed (8 hours) after an AC supply failure. Battery charger had lost supply due to failure of Aurora feeder supplying the AC distribution board. Although the incident was due to batteries not performing as designed this incident raises concerns on relying on third parties to supply AC distribution systems at key locations such as Sheffield Substation.

A second incident occurred during planned work at Sheffield in 2005. The 110kV bus tripped resulting in loss of supply to Railton, Devonport, Ulverstone and Wesley Vale substations. Because the AC supply is fed from either Devonport or Railton Substations via Aurora Energy distribution system, this resulted in a loss of the AC supply to Sheffield Substation. An investigation into the fault identified a delay in restoration resulted from loss of the AC supply at Sheffield due to the inability to tap the transformers automatically.

A third incident happened in 2015 at Farrell Substation when snow loading caused the extended outage of the 22 kV distribution network due to inability for operating personnel to drive to site. This resulted in inability for any tap change control, operation of compressors for EHV CB operation (FA-B452 locked out) and DC batteries coming close to being fully discharged.

7.1.4 Environmental Risk

TasNetworks has taken measures to mitigate the risk associated with an oil spill from oil filled station service transformers by constructing bunds around structure mounted oil filled transformers and replacing units with dry type air insulated station service transformers in substations.

7.2 Special Operation and Design Issues

7.2.1 Operational Issues

There are currently no specific capacity issues with the existing AC distribution systems. However, when substations are upgraded or augmented, the number of circuits of the existing distribution board is often not sufficient to provide supply to all circuits. In such instances replacement of the AC distribution board is included in the substation redevelopment.

TasNetworks' AC distribution system standard requires station service transformers to have a minimum rated capacity of either 100 or 150 kVA unless there are additional specific requirements. During major maintenance work, which may require higher capacities, TasNetworks expect the service provider (contractor) to have their own means of AC supply. This is typically achieved by the use of mobile generators.

7.2.2 Design issues

The AC distribution system technical standard calls for two independent AC supply systems with two station service transformers supplied individually by two cables. These two systems should also be inter-connectable at the low voltage bus. Most of the sites now have duplicate AC supply systems, allowing a more reliable supply, flexibility and ease of operation and maintenance.

There are 10 sites which have only one station service transformer. They can be grouped into two categories;

1. sites which have a single power transformer and
2. sites with multiple power transformers.

The sites with a single station services transformer that only have one power supply transformer are shown in Table 3. At these sites it is not critical to duplicate the station services transformer since there is still a single point of failure in the power transformer.

The sites with a single station services transformer that have two power supply transformer are also shown in Table 3. These sites are ideal candidates for duplicated supply to increase station AC reliability. A review of the need for dual station services transformers has been undertaken and as the stations listed are all readily accessible, ie. are not in remote rural locations, for any failure of their respective station service transformers operators can be on-site quickly and they also have emergency AC generator connection points.

Some of these sites are built with provisions for future addition of the second system.

Table 3: Substations with only one SSVT

Site	Single power transformer	Multiple power transformers	Action
Avoca Substation	Yes		None
Derby Substation	Yes		None

Derwent Bridge Substation	Yes		None
Huon River Substation	Yes		None
Meadowbank Substation	Yes		None
Que Substation	Yes		None
Tungatinah Substation	Yes		None
Bridgewater Substation		Yes	With recent HV switchgear replacement included dual 11 kV supply to single SSVT.
Emu Bay Substation		Yes	Investigate having second SSVT. Proposal is to keep single SSVT and have dual HV supply.
Rokeby Substation		Yes	With recent HV switchgear replacement included dual 11 kV supply to single SSVT.

In addition there are some substations sites that do not have on-site station service voltage transformers and rely on distribution supply from another substation. The Farrell and Sheffield substations are critical 220 kV sites where the loss of AC supply would result in significant operational limitations or delays in restoring supply in the event of a fault. These sites are ideal candidates for a station service power voltage transformer (SSPVT). An SSPVT at these sites would be fed from the EHV network and would provide reliable AC supply in the event the power supply is not available from their current distribution substation source. A SSPVT has recently been installed at Farrell Substation whilst Sheffield Substation has been accessed as being OK with current arrangement of supply from the distribution network.

AC distribution systems design issues relate mainly to the obsolete AC distribution systems and technologies and their inability to meet the demands of a modern substation satisfactorily. The design issues that are common across TasNetworks' AC distribution population include:

- Obsolete technology;
- Obsolete distribution boards and fuses that present safety and reliability concerns and do not conform to current best-practice and industry standards;
- The inability for manufacturer and the industry to technically support obsolete designs;
- The lack of sufficient spares to adequately maintain expected service and performance levels; and
- Not having enough circuits to supply needs of modern equipment after rehabilitations.

7.3 Summary of Risk

In general, the performance of the AC distribution systems in substations has been acceptable.

Although there are no major issues directly related with the performance of AC distribution system, there are certain occupational safety concerns at some locations. One concern is the lack of working clearance at the back of panels which have exposed terminals, giving rise to an occupational health and safety issue. Apart from that, there are issues such as collection of dust on terminals and possibility of flashovers due to insect or rodent interference. These sites do not comply with the current Australian standard AS 3000 'Wiring Rules' although they all were compliant to the standard that existed at the time of construction. Refer Appendix B for details.

The major issues identified in the review of the AC distribution system population are:

- Lack of available information on equipment associated with AC supply systems (other than station service transformers);
- Injection points are required at a number of sites to enable the connection of a diesel generator;
- 10 sites do not have duplicate AC systems;
- 3 sites have AC supply systems which do not conform to current Australian Standards and pose an occupational health and safety risk due to substandard clearances and exposed conductors and terminals;
- At shared Hydro Tasmania sites, TasNetworks does not own the AC supply systems; and
- At two critical 220 kV stations, TasNetworks relies on distribution feeders from remote sites for AC supply. They are Sheffield and Liapootah. Of these, Sheffield is fed by two separate distribution 22 kV feeders and Liapootah has one feeder. TasNetworks does not own any station service transformers at Liapootah.

8 Management Plan

8.1 Historical

Historically, management of AC distribution system has been undertaken based primarily on condition and condition assessments. This will be continued into the future through inclusion of a Condition Based Risk Management (CBRM) program.

8.2 Strategy

The management strategies adopted to mitigate the risks associated with AC distribution system are monitored on an ongoing basis to ensure they are effective and relevant to achieving TasNetworks' risk management objectives. Practices are reviewed on a regular basis taking into account:

- Past performance;
- Manufacturer's recommendations;
- Industry practice (derived from participation in technical forums, benchmarking exercises and discussions with other transmission companies); and
- Availability of new technology.

Failures within AC distribution system may cause serious or catastrophic damage to the assets, so allowing failures to occur represents a real risk to the surrounding infrastructure.

To reduce the risk of an AC distribution system failure, TasNetworks has adopted the following specific strategies to address the predominant causes and consequences of failure.

8.2.1 Routine Maintenance

There is a fundamental requirement for TasNetworks to periodically inspect its assets to ensure their physical state and condition does not represent a hazard to the public and to the electricity supply. The AC distribution system has a high criticality value, so a preventative corrective maintenance program represents a cost effective alternative to a reactive corrective maintenance program.

8.2.2 Routine Maintenance versus Non Routine Maintenance

Failures within AC distribution system may cause serious or catastrophic damage to the asset. These assets are located in critical network points, so allowing failures to occur represents a real risk to the stability of the electrical system. The AC distribution system has a high criticality value, so a preventative corrective maintenance program represents a cost effective alternative to a reactive corrective maintenance program.

8.2.3 Refurbishment

Where AC distribution systems 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.

8.2.4 Planned Asset Replacement versus Reactive Asset Replacement

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. Reactive replacements are generally several times more expensive, incurring overtime, call out penalties and additional repair costs to cable terminations and nearby infrastructure.

8.2.5 Non Network Solutions

The role of the AC distribution systems generally cannot be cost effectively substituted via upgrading other infrastructure on the network.

8.2.6 Network Augmentation Impacts

TasNetworks' requirements for developing the power transmission system are principally driven by five elements:

1. Demand forecasts;
2. New customer connection requests;
3. New generation requests;
4. Network performance requirements; and
5. National electricity rules (NER) compliance.

Details of planned network augmentation works can be found in TasNetworks Regional Development Plan, which is updated on an annual basis.

Proposed network augmentation projects identified in the Network Development Plan will have a minimal impact on the AC distribution system population from an asset management perspective. Additional costs associated with new AC distribution systems installed as part of network augmentation projects will impact on the ten-year projected operational expenditure, since maintenance and testing needs to be performed as detailed in the maintenance plan.

8.3 Routine Maintenance

AC distribution systems consist generally of low maintenance equipment. Inspection of the AC system is carried out as part of the general quarterly substation inspection, which includes visual inspections. Any defects are raised through TasNetworks' corrective work and defect management system. Apart from that necessary corrective maintenance such as replacement of fuses are carried out as and when required.

8.4 Non Routine Maintenance

Minor and major asset defects that are specifically identified during asset inspections and routine maintenance or through other ad-hoc site visits, are prioritised and rectified as per the recommendations set out in TasNetworks condition assessment report and general asset defects management process.

The methodology used to develop and manage non routine maintenance is adjusted to meet the option analysis completed specific for the defect to meet the performance criteria set out in TasNetworks' risk framework, with the objective to return to service and prevent asset failure.

8.5 Regulatory Obligations

8.5.1 Service Obligation for Network Assets

TasNetworks' Service Target Performance Incentive (STPIS) scheme, which has been produced in accordance with the Australian Energy Regulator's (AER's) Service Standards Guideline, is based on plant and supply availability. The incentive scheme includes the following specific measures:

a. Plant availability:
    i. Transmission line circuit availability (critical and non-critical); and
    ii. Transformer circuit availability.
b. Supply availability:
    i. Number of events in which loss of supply exceeds 0.1 system minute; and
    ii. Number of events in which loss of supply exceeds 1.0 system minutes.

Details of the STPIS scheme and performance targets can be found in TasNetworks' TSMP.

There are currently no specific service level obligations for AC distribution systems.

8.5.2 Service Obligations for Non-regulated Assets

8.5.2.1 Hydro Tasmania

TasNetworks has a Performance Incentive (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 substation assets. An overview of Hydro Tasmania PI scheme and performance targets can be found in the Connection Agreement.

8.5.2.2 Tamar Valley Power Station (TVPS)

TasNetworks has a PI scheme in place with Tamar Valley Power Station (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 Connection Agreement.

8.5.2.3 Major Industrial Direct Customer Connections

TasNetworks have a number of direct connections to major industrial customers through EHV and HV substations. The following sites have asset category assets providing these direct connections:

- Boyer Substation (6.6 kV);
- George Town Substation (220 kV & 110 kV);
- Hampshire Substation (110 kV);
- Huon River Substation (11 kV);
- Newton Substation (22 kV);
- Port Latta Substation (22 kV);
- Que Substation (22 kV);
- Queenstown Substation (11 kV);
- Risdon Substation (11 kV);
- Rosebery Substation (44 kV); and
- Savage River Substation (22 kV).

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

8.6 Replacement

Replacement of aged or non-conforming AC distribution systems is generally integrated into other capital works such as augmentations or redevelopments. Where specific design issues and/or compliance to standards is not satisfactory, TasNetworks will progressively replace, or were possible refurbish AC distribution systems in order to maintain or improve transmission performance and reliability.

The decision to replace or decommission AC distribution systems is not driven specifically by age but rather considers a combination of other criteria in the decision process, such as obsolete design, spares availability and manufacturer support. Degradation of station service transformers, non-compliance with AS3000 and deteriorated wiring at some sites is factored into replacement and refurbishment programs, as appropriate. AC distribution system functionality, reliability and integration with other electrical systems need to keep abreast of technological advances in order to satisfy system and customer requirements. It is thus incumbent upon TasNetworks to ensure that such factors are accounted for in strategy development.

Recently completed or future AC distribution systems to be replaced as standalone projects in the period 2013-2023 are as follows:

- Avoca
- Boyer
- Emu Bay
- Farrell
- Meadowbank
- New Norfolk
- Rokeby

Other AC distribution system replacements will be conducted as needed in conjunction with other projects.

8.7 Potential future technology/installations

TasNetworks has as one of its corporate strategies to provide the lowest sustainable prices. It has been identified to by improving energy efficiency and using solar generation at substations will reduce our operational expenditure. Improving energy efficiency and use of renewable energy resources could also has a positive public perception. These benefits align with the TasNetworks strategic measures for our customers and our business.

There has been some preliminary work undertaken to identify which AC distribution systems could be enhanced with the addition of PV cells (solar system). Preliminary report on substation solar capability has been prepared (R6033989). Although this report demonstrates some minor benefits in regards to reducing operating expenditure mainly due to energy charges, there is some reticent in allowing solar panels to be installed within the substation and especially on control/switchroom roofs. It is preferred to keep roofs free from additional infrastructure to ensure integrity and to not introduce any potential for water leakage due to roof penetrations. The introduction of PV cells in substations to supplement the station service supply is to be followed up in the 2019-24 regulatory period.

8.8 Program Delivery

The needs assessment and options analysis for undertaking an asset management activity is documented in the Investment Evaluation Summary for that activity.

The delivery of these activities follows TasNetworks' end to end (E2E) works delivery process.

8.9 Spares Management

Most components associated with AC distribution systems are off the shelf components and are not required to be kept as spares. The only major asset that is not currently held as a system spare is a station service transformer. In the event of a failure at a single station service transformer site, a transformer will be relocated from a non-critical site that has a redundant transformer until a replacement can be procured.

8.10 Disposal Plan

Disposal of AC distribution systems will be undertaken in accordance with relevant standards and procedures.

8.11 Summary of Programs

Table 44 and 5 provide a summary of all of the programs/projects described in this management plan.

Table 4: Summary of AC distribution system programs

Work Program	Work Category	Work Category	Project/Program
Routine Maintenance	CMACS	Corrective maintenance	S001-SUBS-Corrective-AC Supplies

Table 5: Summary of AC distribution system CAPEX programs / projects

Work Program	Work Category	Project title	Project/Program details
Capital	RENSB	AC Supply renewal	Identify which if any substations require LV AC system renewal work or alternative supply arrangement. Undertake required work to ensure any identified AC distribution systems are upgraded and replaced as needed and to provide on-site AC supply (install power VT's) if also identified. This could include installation of PV cells.

9 Financial Summary

9.1 Proposed OPEX Expenditure Plan

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

9.2 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.

A prudent capital investment strategy has been developed to address the design and performance issues associated with the AC distribution systems, especially in substations where there is unreliable AC supply. A CAPEX budget has been proposed that allows for required renewal works as identified during routine inspections..

The capital plan also includes potential investment in installation of photovoltaic cells. The power consumed by TasNetworks substations is metered by Aurora retail and comes at a significant operational cost each year. In an attempt to lower operational expenditure, TasNetworks is proposing the installation of solar photovoltaic cells to offset power consumption. The following sites have potential for the installation of a photovoltaic system.

- Bridgewater
- Burnie
- Devonport
- Hadspen
- Kingston
- Norwood
- Queenstown
- Sheffield
- Rosebery

9.3 CAPEX – OPEX trade offs

The operating expenditure programs are essential for identifying assets that require replacement for condition-based reasons. There is a positive relationship between these two categories in that regular inspection programs gather continuous condition information of the assets to better target asset replacements and identify any asset trends. Maintenance and repair activities also defer the requirement for capital expenditure and increase the likelihood of the asset operating for as long as possible within the network.

10 Related Standards and Documentation

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

TasNetworks documents:

1. WASP Asset Register – Data Integrity Standard – Station Service Transformer R17081
2. Strategic Asset Management Plan R248812
3. TasNetworks' Annual Planning Report, 2017 R689487
4. AM8 Asset Condition Review – project report June16 FINAL R503361
5. Engineering and Asset Services operational expenditure planning methodology, D11/102320.

Technical requirements for new AC Distribution systems are detailed in the following standards/specifications:

6. AC Distribution System Standard TNM-GS-806-0829 R565984

Other standards and documents:

7. Sinclair Knight Mertz report, Assessment of proposed regulatory asset lives, August 2013 R192773
8. Australian Standard AS 4360 Risk Management, Standards Australia
9. Australian Standard AS 3000 Electrical Installations, Standards Australia

11 Appendix A – Summary of Programs and Risk

Description	Work Category	Risk Level	Driver	Expenditure Type	Residual Risk
S001-SUBS-Corrective-AC Supplies	CMACS	Medium	Customer Financial Regulatory Compliance Reputation Safety	Opex	Low
AC Supply renewal	RENSB	Medium	Customer Financial Regulatory Compliance Reputation Safety	CAPEX	Low

12 Appendix B – Details of Station Service Transformers in Substations

Table 6: Details on station service transformer population (47 sites)

Location	SST	Commissioned	kVA Rating	Rated Operating Voltage (kV)	Manufacturer	Insulation Type	Manufacturer's Type
Arthurs Lake	ST1	2013	100	6.6	Wilson	Mineral Oil	Pole Mounted
Arthurs Lake	ST2	2013	100	6.6	Wilson	Mineral Oil	Pole Mounted
Avoca	ST1	2000	100	22	TMC	Epoxy	Resin
Boyer	ST1	1988	100	22	Baldwin	Mineral Oil	Ground Mounted fully insulated
Boyer	ST2	1988	250	6.6	TMC	Epoxy	Resin
Bridgewater	ST1	1979	100	11	Baldwin	Mineral Oil	Ground Mounted fully insulated
Burnie	ST1	2004	300	22	TMC	Epoxy	Resin
Burnie	ST2	2004	300	22	TMC	Epoxy	Resin
Castle Forbes Bay Tee	ST1	2016	150	110	Koncar	Mineral Oil	VPT-123
Chapel Street	ST1	1990	500	11	Wilson	Mineral Oil	Ground Mounted fully insulated
Chapel Street	ST2	1983	500	11	Baldwin	Mineral Oil	Ground Mounted fully insulated
Creek Road Substation	ST1	2001	300	33	Alstom	Epoxy	ITG 330-6
Creek Road Substation	ST2	2001	300	33	Alstom	Epoxy	ITG 330-6
Derby	ST1	2005	150	22	TMC	Epoxy	Ground Mounted fully insulated
Derwent Bridge	ST1	1996	25	22	Tyree	Mineral Oil	Pole Mounted
Devonport	ST1	2006	150	22	Trasfo	Epoxy	Resin
Devonport	ST2	2006	150	22	Trasfo	Epoxy	Resin
Electrona	ST1	2008	150	11	TMC	Epoxy	Resin
Electrona	ST2	2008	150	11	TMC	Epoxy	Resin
Emu Bay	ST1	1938	100	11	Electric Plant Manufacturer	Mineral Oil	Structure mounted

Location	SST	Commissioned	kVA Rating	Rated Operating Voltage (kV)	Manufacturer	Insulation Type	Manufacturer's Type
					Ltd		
Farrell	ST2	1982	200	22	A.S.E.T.	Mineral Oil	Pole Mounted
Farrell	FA-E797	2017	150	110	Koncar	Mineral Oil	PVT
George Town	ST1	2000	300	22	TMC	Epoxy	Ground Mounted fully insulated
George Town	ST2	2000	300	22	TMC	Epoxy	Ground Mounted fully insulated
Hadspen	ST1	2006	150	22	ABB	Epoxy	1LKR051015TER
Hadspen	ST2	2006	150	22	ABB	Epoxy	1LKR051015TER
Huon River	ST1	2007	150	11	TMC	Epoxy	Resin
Kermandie	ST1	2006	150	11	TMC	Epoxy	Resin
Kermandie	ST2	2006	150	11	TMC	Epoxy	Resin
Kingston	ST1	2012		11	Trasfo	Epoxy	Ground Mounted fully insulated
Kingston	ST2	2012		11	Trasfo	Epoxy	Ground Mounted fully insulated
Knights Road	ST1	1989	50	11	Tyree	Mineral Oil	Structure mounted
Knights Road	ST2	1989	50	11	Tyree	Mineral Oil	Structure mounted
Lindisfarne	ST1	2006	150	33	TMC	Epoxy	Resin
Lindisfarne	ST2	2006	150	33	TMC	Epoxy	Resin
Meadowbank	ST1	2000	100	22	TMC	Epoxy	Ground Mounted exposed bushing
Mornington	ST1	2011		33	TMC	Epoxy	Resin
Mornington	ST2	2011		33	TMC	Epoxy	Resin
Mowbray	ST1	2006	150	22	TMC	Epoxy	Ground Mounted fully insulated
Mowbray	ST2	2006	150	22	TMC	Epoxy	Ground Mounted fully insulated
New Norfolk	ST1	1987	100	22	Baldwin	Mineral Oil	Structure mounted
New Norfolk	ST2	1987	100	22	Baldwin	Mineral Oil	Structure mounted

Location	SST	Commissioned	kVA Rating	Rated Operating Voltage (kV)	Manufacturer	Insulation Type	Manufacturer's Type
Newton	ST1	2013	50	22	Baldwin	Epoxy	Structure mounted
Newton	ST2	2013	100	11	Tyree	Epoxy	Structure mounted
North Hobart	ST1	1977	100	11	Baldwin	Mineral Oil	Ground Mounted fully insulated
North Hobart	ST2	1977	100	11	Baldwin	Mineral Oil	Ground Mounted fully insulated
Norwood	ST1	2004	150	22	TMC	Epoxy	Ground Mounted fully insulated
Norwood	ST2	2004	150	22	TMC	Epoxy	Ground Mounted fully insulated
Palmerston	ST1	2006	150	22	TMC	Epoxy	Resin
Palmerston	ST2	2006	150	22	TMC	Epoxy	Resin
Port Latta	ST1	2006	150	22	Trasfo	Epoxy	Resin
Port Latta	ST2	2006	150	22	Trasfo	Epoxy	Resin
Que	ST2	1980	100	22	Baldwin	Mineral Oil	Structure mounted
Queenstown	ST1	2004	150	22	TMC	Epoxy	Ground Mounted fully insulated
Queenstown	ST2	2004	150	22	TMC	Epoxy	Ground Mounted fully insulated
Railton	ST1	2011	100	22	TMC	Epoxy	Ground Mounted fully insulated
Railton	ST1	2011	100	22	TMC	Epoxy	Ground Mounted fully insulated
Risdon	ST2	2006	150	33	TMC	Epoxy	Resin
Risdon	ST1	2006	150	33	TMC	Epoxy	Resin
Rokeby	ST1	1982	100	11	Baldwin	Mineral Oil	Ground Mounted fully insulated
Rosebery	ST1	2015	200	22	Schneider	Mineral Oil	Ground Mounted fully insulated
Savage River	ST1	2006	150	22	Trasfo	Epoxy	Resin

Location	SST	Commissioned	kVA Rating	Rated Operating Voltage (kV)	Manufacturer	Insulation Type	Manufacturer's Type
Savage River	ST2	2006	150	22	Trasfo	Epoxy	Resin
Scottsdale	ST1	2005	150	22	TMC	Epoxy	Ground Mounted fully insulated
Scottsdale	ST2	2005	150	22	TMC	Epoxy	Ground Mounted fully insulated
Sheffield	ST1	1997	500	22	A.S.E.T.	Mineral Oil	Ground Mounted fully insulated
Sheffield	ST2	1997	500	22	A.S.E.T.	Mineral Oil	Ground Mounted fully insulated
Smithton	ST1	2003	300	22	TMC	Epoxy	Resin
Smithton	ST2	2003	300	22	TMC	Epoxy	Resin
Sorell	ST1	2011	100	22	TMC	Epoxy	Resin
Sorell	ST2	2011	100	22	TMC	Epoxy	Resin
St Leonards	ST1	2012	150	22	TMC	Epoxy	Ground Mounted fully insulated
St Leonards	ST2	2012	150	22	TMC	Epoxy	Ground Mounted fully insulated
St Marys	ST1	1984	100	22	Baldwin	Mineral Oil	Structure mounted
St Marys	ST2	1984	100	22	Baldwin	Mineral Oil	Structure mounted
Trevallyn Substation	ST1	1998	250	22	Trihal	Epoxy	Ground Mounted fully insulated
Trevallyn Substation	ST2	1998	250	22	Trihal	Epoxy	Ground Mounted fully insulated
Triabunna	ST1	2006	150	22	TMC	Epoxy	Resin
Triabunna	ST2	2006	150	22	TMC	Epoxy	Resin
Tungatinah	ST1	2011	150	22	ABB	Epoxy	Resin
Ulverstone	ST1	1984	100	22	Baldwin	Mineral Oil	Structure mounted
Ulverstone	ST2	1984	100	22	Baldwin	Mineral Oil	Structure mounted
Wesley Vale	ST1	2006	150	11	Trasfo	Epoxy	Resin
Wesley Vale	ST2	2006	150	11	Trasfo	Epoxy	Resin

Source: WASP Asset registration database

Table 7 provides a summary on the types of station service transformers in service listed in Table 6.

Table 7: Summary of station service transformers by type of construction and age group

Age Group	Ground Mounted	Pole Mounted	Resin	Structure Mounted	Total
0-4	2	2		2	5
5-9	6		7		13
10-14	9		25		34
15-19	5		3		8
20-25	2	1			3
>25	7	1	1	10	19
Total	29	4	36	12	83

13 Appendix C- Details of AC Distribution Systems in Substations and Switching Stations

Table 10 includes details of emergency AC connection points at all substations. These connection points are typically a 50 A rated 3 phase inlet suitable for connection of TasNetworks emergency trailer mounted AC generator.

Table 8: Details of AC distribution board population (at 47 substations+3 switching stations)

Location	No. of SSTs	Commissioned #	Type of AC distribution board	Emergency AC connection point?	Condition/other comments
Arthurs Lake	2	2013	S	YES	
Avoca	1	2000	NS/C	YES	
Boyer	2	1988	NS/C	YES	
Bridgewater	1	1979	NS/C	YES	
Burnie	2	2004	S	YES	
Castle Forbes Bay T	1	2016	NS/C	NO	PVT installed to support motorised disconnector.
Chapel Street	2	1990	S	YES	
Creek Road Substation	2	2001	NS/C	YES	
Derby	1	2005	S	YES	
Derwent Bridge	1	1996	NS/C	NO	
Devonport	2	2006	S	YES	
Electrona	2	2008	S	YES	
Emu Bay	1	1938	NS/C	YES	
Farrell	2	1982	NS/NC	YES	1 x 22 kV Aurora feeder + New PVT installed in 2017
George Town	2	2000	S	YES (110kV only)	
Gordon	-	-	-	-	Hydro asset
Hadspen	2	2006	S	YES	
Huon River	1	2007	S	NO	
Kermandie	2	2006	S	YES	
Kingston	2	2012	S	YES	
Knights Road	2	1989	NS/C	YES	
Lindisfarne	2	2006	S	YES	
Meadowbank	1	2000	NS/C	YES	
Mornington	2	2011	S	YES	
Mowbray	2	2006	S	YES	

Location	No. of SSTs	Commissioned #	Type of AC distribution board	Emergency AC connection point?	Condition/other comments
New Norfolk	2	1987	NS/C	YES	
Newton	2	2013	S	YES	
North Hobart	2	2013	S	YES	
Norwood	2	2004	S	YES	
Palmerston	2	2006	S	YES	
Port Latta	2	2006	S	YES	
Que	1	1980	NS/NC	YES	
Queenstown	2	2004	S	YES	
Railton	2	2011	S	YES	
Risdon	2	2006	S	YES	
Rokeby	1	1982	NS/C	YES	
Rosebery	1	2015[1]	S	YES	
Savage River	2	2006	S	YES	
Scottsdale	2	2005	S	YES	
Sheffield	2	1997	S	YES	22 kV Aurora feeder
Smithton	2	2003	S	YES	
Sorell	2	2011	S	YES	
St Leonards	2	2012	S	YES	
St Marys	2	1984	NS/C	YES	
Trevallyn Substation	2	1998	NS/C	YES	
Triabunna	2	2006	S	YES	
Tungatinah	1	2011	S	YES	
Ulverstone	2	1984	NS/C	YES	
Waddamana	-	-	S	YES	
Wesley Vale	2	2006	S	YES	
Switching Station					
Castle Forbes Bay Tee	1	2016	NS/C	NO	PVT installed to support motorised disconnector.
Hampshire	-		-	-	
Liapootah	-		S	YES	Hydro provides AC supply

Note: * - year of commissioning of SST. AC board can be assumed similar vintage.

[1] SST replaced in 2015. 1983 was original SST installation date.

- Types of AC distribution board: S – Standard installation, NS/C – Non standard but compliant to AS 3000, NS/NC – Non standard and non-compliant to AS 3000 (See section 7.2 for more details).