Project Justification Report

Provisional Transformer

7523384

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Project Summary and Checklist

Project Deliverable	
Provisional Transformer	
Select Project Type	Network Asset - New or Replacement
Asset Management Project (AMP)	Yes
Target or Schedule Defined with Reporting Tolerances	No
Project Benefit	Other
Increased network capacity to meet demand.	
Cost Estimate Completed & Attached	No
Risk Assessment Completed	No
Safety Risk Identified / Addressed and/or Safety Plan	No

Document Control

Version Control

Date	Version	Author	Description of Change
29 May 2014	0.1		Draft for Client Review
30 May 2014	0.1		Final

Related Documents

Document Title	DM5 Reference / Sharepoint Link / Location

Document Authorisation

Approved by (Signature)	Name	Role	Date

Purpose

The purpose of this document is to provide the basis for choosing the appropriate mode of operation of a new system transformer and demonstrate prudency and efficiency of the investment in the context of ActewAGL's long term augmentation plans, business goals and vision for the ACT network.

Executive Summary

This Project Justification Report investigates and recommends that the Provisional transformer be installed at East Lake zone substation to establish N-I security of supply.

Definition of Project Need

Business Objectives

The ActewAGL business objectives are to manage the distribution network in a prudent and cost efficient manner while meeting the requirements of reliability and security of supply of the Electricity Distribution (Supply Standards) Code. To this extend the reference documents in Table 1 provide the basis and requirements of the network planning drivers and guidelines.

The reference documents from external organisations can be accessed from the ActewAGL websites.

Table 1: Rules, Standards and Guidelines for Distribution Network Planning

Doc No.	Description	Source
1	Utilities ACT 2000 (ACT)	ACT
2	ACT Electricity Distribution Supply Standards Code	ACT
3	Service Target Performance Incentive Scheme (STPIS)	AER
4	Distribution Network Planning and Expansion Framework	ActewAGL
5	Distribution Network Augmentation Criteria	ActewAGL
6	National Electricity Rules	AER
7	Network Performance Targets	ActewAGL
8	Demand Side Management Planning Process	ActewAGL
9	ACTPLA Criteria	ACTPLA
10	TAMS Criteria	TAMS
11	Design Manual	ActewAGL
12	NPV Methodology	ActewAGL
13	RIT–(D) Process	AER
14	Federal Government Guidelines	SEWPEC

Project Objectives

The objectives of the Provisional Transformer project are to identify and select a prudent and cost efficient mode of operation for the provisional transformer that:

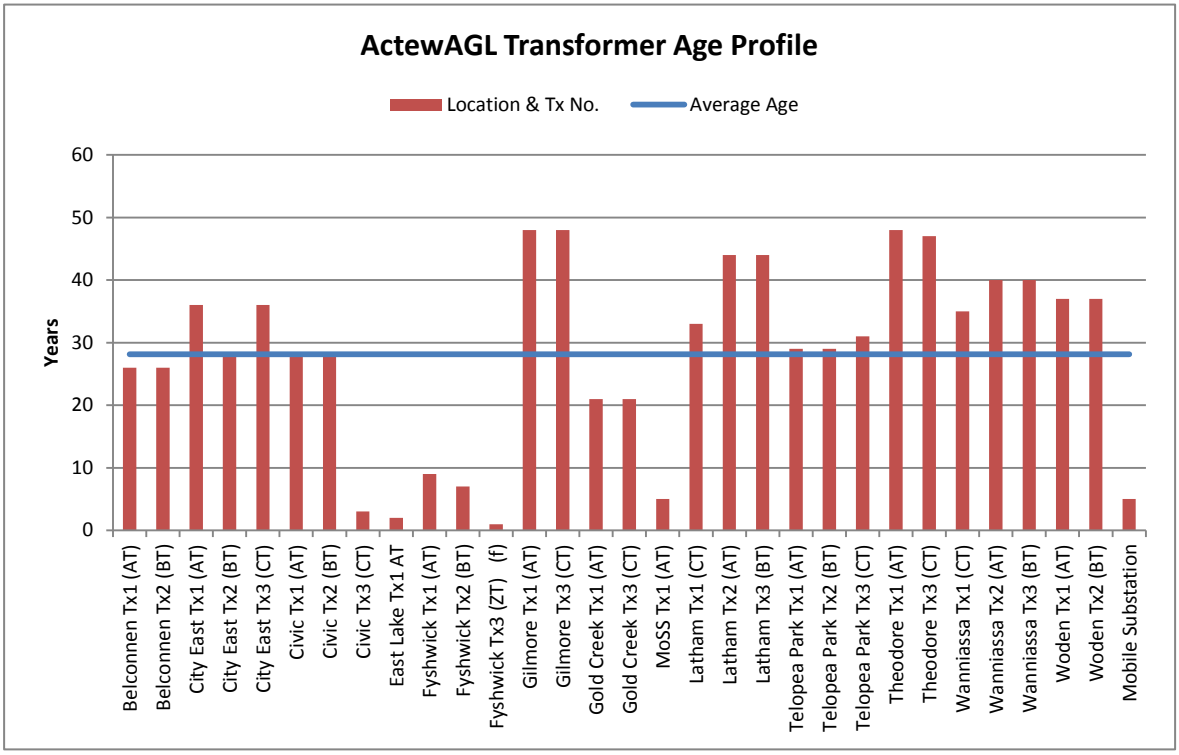
- Optimises the value of the capital investment
- Enhances the system reliability and security of supply
- Supports the relevant legislation, regulations and administrative requirements

Investment Description

ActewAGL's network includes a fleet of 31 power transformers located at 12 zone substations. The majority of the transformers are 132/11kV transformation with the exception of the Fyshwick transformers which are 66/11kV transformation.

The age profile of the ActewAGL power transformers shows that more than 50% are approaching, or exceed 30 years of age, and the oldest units are 48 years of age. Figure 1 shows the age profile of the ActewAGL power transformer population.

Figure 1: Power Transformer Age Profile



Based on Jacobs SKM's international experience in Australia, U.K, New Zealand, Asia, and South Africa the operational life of power transformers varies between 45 and 60 years. This suggests that ActewAGL's power transformers at Gilmore and Theodore are approaching the end of their serviceable lives, with perhaps 10-15 years of remaining life.

ActewAGL has experienced two catastrophic transformer failures in the last 10 years. In both cases the transformers were aged 47 years at the time of their failure. The first failure was in 2007 and the second failure in 2013. The second transformer had undergone a mid-life refurbishment 13 years earlier.

An audit, initiated by ActewAGL in 2012, reviewed the asset condition of the power transformers and found that most of the transformers:

- operate well within their normal parameters
- are well maintained
- are subject to regular oil condition testing with no adverse findings
- have some evidence of typical aging characteristics

The typical failure rate of power transformers based on a study of Australian based transformers is 3% per annum. Statistically, in a population of 31 transformers, one transformer could be expected to fail every year.

As a prudent and cost efficient network operator ActewAGL investigated and are proposing to invest in a provisional power transformer within the next regulatory period.

This report considers several possible options for the location and mode of operation of the provisional transformer.

Potential Locations and Operating Modes

Three operational modes are discussed in this report and include:

- Installation as a system spare at an existing substation
- Installation as a rotational system spare to allow refurbishment of aging transformers
- Permanent system installation at East Lake Zone Substation

Option 1: System Spare

As a system spare the purpose of the provisional transformer is to ensure availability of a critical system component to reduce the outage time incurred with a failure, thereby improving the reliability of the network. To achieve this, the transformer needs to be maintained in a fully operational condition and should always be immediately available.

When the spare is needed, it is usually installed under tight time constraints, to this extent the retrieval and installation of the transformer should not be hindered by the requirement for transformer testing and operational constraints. Routine testing and inspections should be performed on a regular basis and in the same manner as an operating transformer. Critical components such as bushings should be immediately available.

As a system spare, the transformer would normally be installed as a fully functional and energized network component, and although energised may not actually be supplying any load. Suitable cost efficient locations for such an installation would be Gilmore, Theodore or East Lake zone substations.

All three of these zone substations have fully equipped transformer bays available that can accommodate a spare transformer installation. An installation at these sites will require the installation of appropriate protection and control equipment and associated cabling works to energize the transformer.

Both Gilmore and Theodore currently operate with transformers that are aged around 48 years and a critical spare at these locations would be a prudent consideration.

East Lake zone substation was commissioned in 2013 as a single transformer installation with provision for a second transformer.

Option 2: Rotational Spare

As a rotational spare the purpose of the provisional transformer is to support station loadings at substations while transformer testing and refurbishments are undertaken.

The aging fleet of transformers require investment in the ongoing reliability of the system. A cost efficient approach is to defer high replacements costs through the refurbishment of the power transformers. Refurbishment of transformers has the potential to extend a transformers operational life by 10 years or more.

ActewAGl is proposing to undertake and complete Degree of Polymerisation (DP), oil and electrical testing to assess the need for either mid-life refurbishment or planned replacement. The testing would require the transformer to be taken off-line and in the case of the DP test the transformer needs to be de-tanked. The testing process takes up to 10 days to complete from the time the transformer is taken off-line to when it is re-energized.

Following an assessment of the level of refurbishment required, refurbishment of the transformers can be done either on-site, or off-site at a factory. The off-site, or factory refurbishment has the benefits of providing a controlled environment for the refurbishment work and the transformer can also potentially be subjected to the vapour phase process to quickly remove all the built up sludge from its windings.

Factory refurbishment, however, carries a high risk of internal winding damage. Power transformer windings become loose with age and shipping a transformer with loose internals can cause irreversible damage to such units.

There is also an operational risk that if a transformer being refurbished is urgently required to be put back into operation, ActewAGL will have limited control and ability to influence the turnaround time after the transformer is shipped to the factory.

On site mid-life refurbishment not only eliminates the transportation costs and risks, but also gives ActewAGL better control over the delivery schedule including ability to use and train in-house resources. During on-site refurbishment, proper care needs to be taken to ensure that there is no ingress of moisture and dust inside the transformer, by adequately covering the transformer at all times.

The on-site refurbishment is recommended as a preferred approach, compared with factory based refurbishment.

At the majority of zone substations the testing and refurbishment of the transformers needs to be undertaken in-situ as inadequate space is available to allow for the removal of the transformer, and relinquishing the transformer bay for the installation of a provisional transformer.

To this extent the opportunity for effectively deploying a provisional transformer is limited, and is it not recommended as an effective and prudent investment.

Option 3: Permanent Installation

As a permanent installation the transformer would be installed at the new East Lake zone substation to establish N-1 security of supply, and compliance with the ACT Electricity Distribution Supply Standards Code.

The East Lake zone substation was established in 2013 as the primary source of supply to support increasing load demands in the South Canberra region. The East Lake zone substation was established as a staged development with the first stage involving the establishment of a single transformer substation. Compliance with security of supply requirements is currently achieved through a three-way N-1 arrangement involving the transfer of loads between Telopea Park, Fyshwick, and East Lake zone substations.

Rapid demand growth on Eastlake is forecast over the next five years through the transfer of load to off-load Fyshwick Zone substation. The demand forecast for East Lake is provided in Table 2. The rapid growth in demand dictates the need for a second transformer to be installed by 2015/16 to maintain N-1 security of supply and compliance with the Distribution Network Augmentation Criteria.

Table 2: East Lake Zone Substation Demand Forecast

Zone Substation	East Lake				
Season		**S**	**W**		
Rating	Continuous	50	50		
	Emergency	-	-		
Post upgrade	Continuous	-	-		
	Emergency	-	-		
Zone substation load forecast, MVA		**50%PoE**		**10%PoE**	
	2014	8.3	16.5	8.3	16.5
	2015	16.6	16.7	16.6	16.7
	2016	16.8	34.1	16.8	34.1
	2017	34.2	46.1	34.2	46.1
	2018	46.2	46.6	46.2	46.6
	2019	46.7	47.1	46.7	47.1
	2020	47.1	47.5	47.1	47.5
	2021	47.6	48.0	47.6	48.0
	2022	48.1	48.5	48.1	48.5
	2023	48.6	49.0	48.6	49.0

Scope

The installation of the provisional transformer will require as a minimum:

- A fully equipped transformer bay including concrete footings, oil bunding, and blast walls
- Protection and control equipment including circuit breakers, surge arrestors, CTs, VTs, relays, metering
- Cabling and commissioning works
- Ongoing testing and inspections

The extent to which the installation of a provisional transformer can be accommodated for each mode of operation options, is summarised in Table 3.

Table 3: Provisional Transformer installation requirements

Mode of Operation	Installation Requirements
System Spare	Both Gilmore and Theodore zone substations can accommodate an additional transformer in existing transformer bays Protection and control equipment will need to be procured and installed Cable and commissioning works will be required
Rotational Spare	The majority of zone substations would require extensive works to secure space and establish a transformer bay
Permanent Installation (East Lake)	East Lake zone substation can accommodate an additional transformer in existing transformer bays Protection and control equipment will need to be procured and installed Cable and commissioning works will be required Once installed at East Lake the provisional transformer can still be used as a system spare for deployment to other locations for a period of time, while the 3-way N-1 capacity exists between Telopea Park, Fyshwick & East Llake. Once Fyshwick is decommissioned, the transformer at EastLake could no longer be considered as a system spare.

On a scope of work basis the options of operating as a system spare and operating as a permanent installation ranks equally favourable, while the rotational spare option does not provide a prudent solution.

Cost

Budgetary provision for the procurement, installation and commissioning of one transformer has been included in the 2014-19 regulatory period at $2.618M.

A comparative estimate of the cost of procuring and installing a provisional transformer is provided in Table 4. The estimate is based on reference estimates used in reviewing capital expenditure programs and projects, and rely upon market information that has gathered from various sources. Based on this estimate the budgetary provision appears reasonable.

Table 4: Cost Estimate

Component	Cost Estimate ($k)
Transformer Bay	-
Protection and control	185

Component	Cost Estimate ($k)
Power Transformer	934
	1,118
EPCM (17%)	190
Overheads (15%)	196
Contingency (30%)	451
Total	**2,623**

The cost of the procurement and installation of the provisional transformer under the system spare and permanent installation options would be similar based on the similarities in the scope of work.

As a rotational spare the cost estimates would potentially vary significantly from one zone substation to the other depending on the need to undertake work at the substation, and to establish a transformer bay. The cost would also accumulate across the number of transformers to be tested and refurbished. The total number of transformers that may require refurbishment is to be confirmed, but could be as high as 22, considering all transformers aged 25 years and older.

On a cost basis the options of operating as a system spare and operating as a permanent installation ranks equally favourable while the rotational spare option is not cost effective.

Risk and Benefits

A high level consideration of risk associated with the implementation of the three modes of operation is summarized in Table 5. On a relative risk basis the permanent installation of the transformer at East Lake delivers the lowest risk option, considering the relative low complexity, handling requirements, and technical alignment requirements.

Table 5: Relative Risk consideration

Risk	System Spare	Rotational Spare	Permanent Installation
Health and Safety	Moderate handling and relocation of the asset. Moderate risk.	Multiple handling and relocation of the asset with highest risk	Least handling of the asset. Low relative risk
Scope	Minimal relative scope of work. Low relative risk.	Various scope of works and complexity. High relative risk	Moderate relative scope of work. Moderate relative risk.
Cost	Low relative cost	High relative cost	Low relative cost
Schedule	Moderate relative schedule risk based on the need to retrieve, transport, install and commission under emergency timeframes and conditions.	High relative schedule risk based on various complexity and installation considerations	Low relative schedule risk associated with a single installation
Technical	Requirement for compatibility matching and technical to allow for emergency installation at a potential contingency site	Requirement for compatibility matching and technical alignment to allow for rotational installation at refurbishment sites	Once off technical specification and alignment with requirements. Low relative risk.

Selection of Preferred Solution

The aging transformer population presents a high reliability risk to ActewAGL and as a responsible network operator, ActewAGL has embarked on a testing and refurbishment program to assess and mitigate the risk.

The refurbishment program will target older transformers first to determine remaining reliable service life and then continue progressively to develop a priority listing of transformers identified for midlife refurbishment and planned replacement.

Investment in a system spare while this refurbishment program is being executed would be considered a prudent investment to maintain the reliability of the system; however, a comparison of risk and benefits to identify the most prudent and cost effective application of the budgetary funds in the upcoming regulatory period suggests that greater benefits would be gained from installing a second transformer at East Lake.

Investing in the installation of a second transformer at East Lake would establish and maintain security of supply and is considered a high priority investment considering the step increase in demand projected for the substation.

Investment in a rotational spare is not considered a workable solution as the majority of the zone substations would not be able to accommodate a spare transformer.

Recommendation

It is recommended that the provisional transformer investment be directed towards the installation of a second transformer at East Lake zone substation to establish and maintain N-1 security of supply in support of the aggressive load growth forecast at the substation over the next five years.