2018-22
POWERLINK QUEENSLAND REVENUE PROPOSAL

Project Pack - PUBLIC

CP.02516
Garbutt Transformer Replacement

Delivering better value

ID&TS - Reset 2017/18-2021/22 Project Proposal for CP.02516 Garbutt Transformer Replacement

Document Approval		
	Name	Position
Prepared by		Project Manager
Reviewed by		Manager Projects
Approved by		Group Manager Infrastructure Delivery

Contents

1. Executive Summary

T046 Garbutt Substation was originally established in 1978 to supply the Ergon Energy distribution network in the region of Townsville in Far North Queensland. The substation has two 132/66kV transformers rated at 71MVA.

The transformers were installed in 1978 and are approaching 40 years of age. A condition assessment carried out in March 2015 (A2184190) highlighted a number of issues with them. They are displaying significant condition issues typical of transformers of this age. The most critical issues being that the winding paper insulation appears to have reached end of life (2015) and significant oil leaks have developed.

It is recommended that action be taken within 3 years.

The objective of this project is to replace both transformers with new 60/80/100MVA units by June 2018.

2. Project Definition

2.1 Project Scope

Briefly, the project consists of replacing both of the existing 2 x 50/70MVA 132/66kV transformers at T046 Garbutt with new 132/66kV 60/80/100MVA transformers.

Decommission, remove and dispose of the redundant transformers.

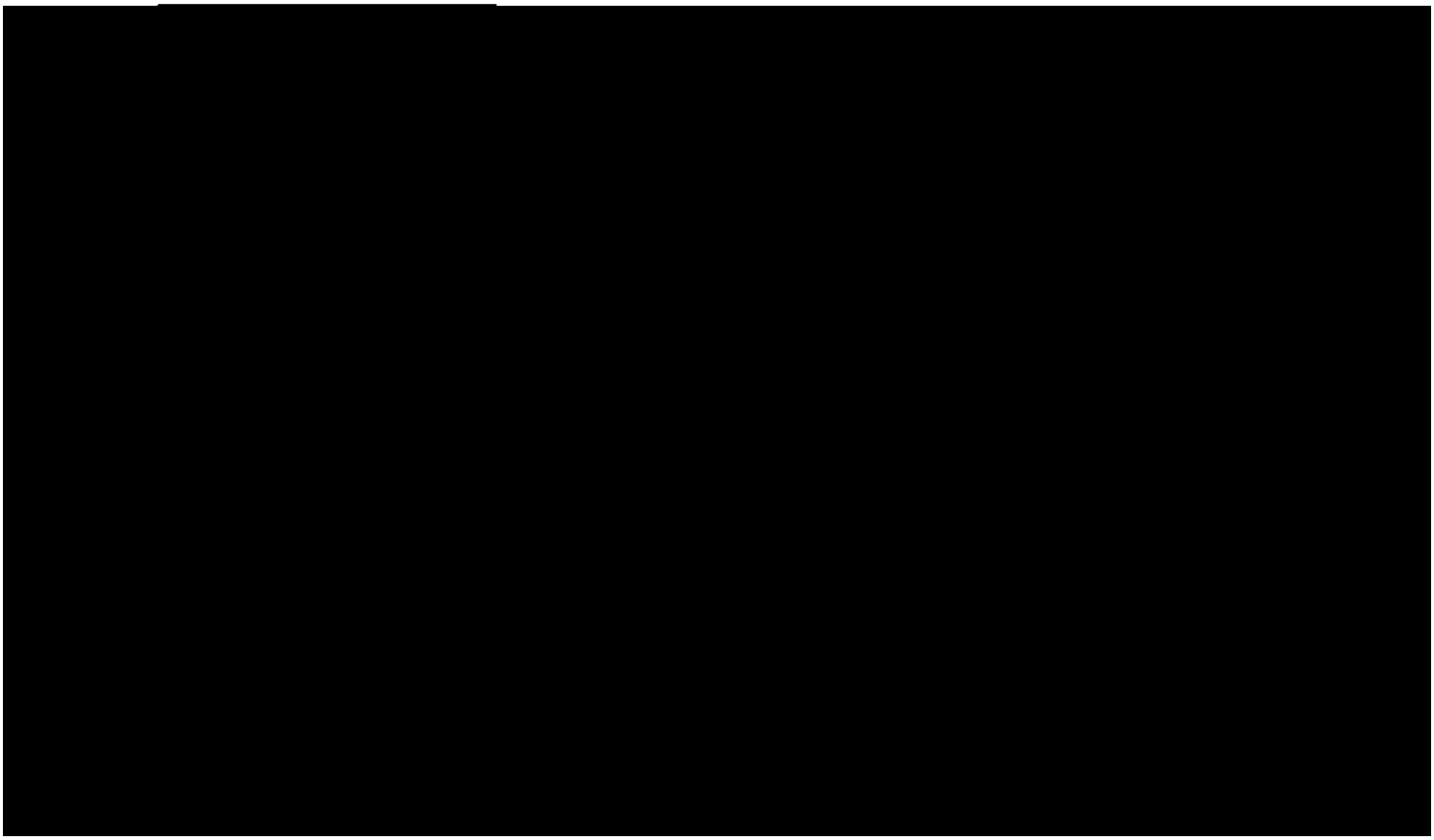
2.1.1 Transmission Line Works

Not applicable.

2.1.2 T046 Garbutt Substation Works

The following work is required at Garbutt:

- Procure, supply and install 2 x new 60/80/100MVA 132/66kV transformers, with on load tap changer and cooling facilities;
- Replace transformer foundations;
- Replace oil separation tank to allow for increased transformer oil quantity on site;
- Establish a new transformer noise wall and blast wall between the new transformers;
- Replace surge arresters;
- Upgrade the existing station services transformers;
- Decommission and dispose of old T1 and T2 transformers;
- Modify protection, automation and communication systems as necessary to accommodate the new transformers;



2.2 Major Scope Assumptions

- 132kV landing spans and strung bus connections are suitable for reuse.
- The 132kV transformer bay plant equipment is suitable for reuse. The plant rating has been checked however the age or the condition of the plant has not been assessed;
- Based on a high level desktop study it has been assumed that a noise enclosure will be required. A detailed noise study would be required to confirm this requirement.
- It has been assumed that long duration outages for each transformer will be available to allow in situ replacement of the transformers.

2.3 Scope Exclusions

- Any work on Ergon assets;
- Replacement or upgrading of the 132kV transformer bay primary plant. Preliminary investigations have shown that the 132kV bay ratings are sufficient.

3. Project Execution

3.1 Project Dependencies & Interactions

Project No.	Project Description	Planned Comm Date	Comment
Pre-requisite Projects			
Co-requisite Projects			
Other Related Projects			

3.2 Site Specific Issues

3.3 Project Delivery Strategy

It is expected that the project will be delivered using a Substation Panel Contractor under a Construct Only contract. Powerlink is expected to perform the design with the Maintenance Service Provider performing the testing and commissioning.

Project Delivery Strategy Matrix		
Design	Earthworks Design	Powerlink
	Civil Design	Powerlink
	Electrical Design (Primary)	Powerlink
	Electrical Design (Secondary) – Protection	Powerlink
	Electrical Design (Secondary) – Automation	Powerlink
	Transmission Line Design	NA
	Telecommunication Design	Powerlink
Procurement	Transformer Procurement	Powerlink
Construction	Earthworks Construction	SPA Contractor
	Civil Construction	SPA Contractor
	Electrical Construction / Installation	SPA Contractor
	Transformer Delivery and Installation	Transformer Manufacturer
Testing	Substation Testing – FAT	Ergon Energy
	Substation Testing – SAT	Ergon Energy
	Substation Testing – Cut-Over	Ergon Energy
	Telecommunication Testing	Ergon Energy

3.4 Proposed Sequence of Works

3.4.1 Project Schedule

To meet the required commissioning date of 30th June 2018 full project approval will be required by 30th June 2016.

High Level Schedule

- Project Approval : 30th June 2016
- Order 1st Transformer : July 2016
- Order 2nd Transformer : Jan 2017
- Design Complete : Jan 2017
- SPA Construct contract awarded : March 2017
- Construction : May 18 - April 2018
- Test/commissioning : Sept/Oct 2017 & April/May 2018
- Final decommissioning/Tidy up : June 2018
- Project Completion : 30th June 2018

3.4.2 Project Staging

Major project stages of the project are considered to be:

Stage	Description/Tasks
1	Non outage prep work including replace oil separation tank and connect to Transformer 1 and transformer 2 drainage systems.
2	Decommission, remove and dispose of old transformer 1 including transformer blast wall, noise wall and foundations. Construct new foundations and install new transformer followed by noise wall and blast wall including all associated electrical works.
3	Test and commission new transformer 1 and associated electrical works.
4	Decommission, remove and dispose of old transformer 2 including transformer blast wall, noise wall and foundations. Construct new foundations and install new transformer followed by noise wall and blast wall including all associated electrical works.
5	Test and commission new transformer 2 and associated electrical works.

3.4.3 Network Impacts and Outage Planning

It has been assumed that outages of each transformer will be available to allow in situ replacement. Detailed outage plans will need to be submitted and outages agreed with network operations to confirm this. Agreement will also be required from Ergon to have the load at risk whilst only supplied on a single transformer. A backup station services transformer/supply will be required while the transformer is out of service.

3.5 Project Health & Safety

The implications of relevant workplace health & safety legislation in delivering the proposed solution have been considered in preparing this estimate. In particular, this estimate includes an allowance for typical safety related activities required in the delivery phase of the project.

3.6 Project Environmental Management

No specific environmental management implications for the delivery of this project have been identified.

4. Project Risk Management

Some allowances have been allowed in the estimate. Please see estimate for details.

Please refer to the assumptions and exclusion as these items have implications for the overall project risk.

5. Project Estimate

5.1 Estimate Summary

Quote Summary

The quotation at current base level and escalated for completion by 30/06/2018at 2.5% CPI per year plus labour rate variations, for CP.02516 Garbutt Transformer Replacement is as follows:

CP.02516 Quotation in $ AUD	Base Levels	Escalated to Compln.	Comment (Costs @ Base Levels)
T046 Garbutt Substation	[redacted]	[redacted]	Replace both of the existing 2x 50/70MVA 132/66kV transformers at T046 Garbutt with 2x new 132/66kV 60/80/100MVA transformers. Decommission, remove and dispose of the redundant transformers. Establish a new transformer blast wall between the new transformers, noise walls. Replace existing transformer foundations. New transformer oil separation tank. Upgrade existing 132kV surge arresters and 66kV surge arresters. Upgrade existing Station Services Transformers. Modify protection and automation systems.
Project Management			
Qleave			
Other Costs			
TOTAL QUOTE (EXCL RISKS AND OFFSETS)	**6,449,850**	**6,708,409**	
Offsets Estimate	**0**	**0**	
TOTAL QUOTE (INCL OFFSETS)	**6,449,850**	**6,708,409**	
Climate	[redacted]		
Construction			
Design			
Risk Estimate	**387,000**	**387,000**	
TOTAL QUOTE (INCL RISKS AND OFFSETS)	**6,836,850**	**7,095,409**	

5.2 Asset Disposal Table

The current net book value of assets to be disposed of as a result of this project are set out in the table below.

CP.02516 Asset Disposal Table. Values current at 30th June 2016

Functional Loc.	Description	Asset	Subnumbe	Book val.	% Disposal	Disposal Value	Currency
T046-T01-1TRF	1 TRANSFORMER	106013	0	140,577.83	100%	140,577.83	AUD
T046-T02-2TRF	2 TRANSFORMER	106014	0	140,577.83	100%	140,577.83	AUD
					Total	281,155.66	AUD

6. References

Document name and hyperlink (as entered into Objective)	Version	Date
Project Scope Report	1.0	June 2015
Estimate Detail	5.0	Jan 2016

Transformer T1 & T2 Condition Assesment
T046 Garbutt Substation

Asset Category	Substation Primary	**Author**	[redacted]	**Authorisation**	[redacted]
Activity	Condition assessment - primary substation plant, power transformers.				
Document Type	Report	**Team**	Primary Design Standards & Asset Investigations		
Issue date	13/03/2015	**Date of site visit**	29/01/2015		

Date	Version	Objective ID	Nature of Change	Author	Authorisation
13/03/2015	1.0	A2184190	Original		
06/01/2016	2.0	zA137703	Review and update	[redacted]	

IMPORTANT: - This condition assessment report provides an overview of the condition of power transformer/s (excluding internal transformer inspections) and high level indications of their residual reliable service life. As it is a snapshot in time and subject to the accuracy of the assessment methodology and ongoing in-service operating environment, the comments in this report are valid for 3 years from the date of the site visit stated above.

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1. SUMMARY

Both of these General Electric transformers are 38 years old and in line with the requirements of AM-POL-0056, a condition assessment has been performed towards “end of life” including an on-site visual assessment combined with a desktop analysis of historical oil and insulation test data, maintenance history and through fault data history where available.

Although power transformer condition is monitored closely, the exact point of power transformer failure cannot be accurately predicted. As the consequences associated with catastrophic power transformer failure in electricity transmission are very high in terms of the financial costs, and potential loss of supply, impact on safety of personnel and public and on the environment (fire, gasses, oil disposal, etc.), the asset management strategy employed is to plan and execute replacement before the actual failure occurs. This is done by assessing the condition of major transformer components and estimating their end of life as well as that of the overall transformer. As the transformer systems and components deteriorate their probabilities of failure increase leading to an increased risk cost and decreased transformer availability.

While component repair or replacement may be possible, in many cases they would provide very little or no benefit with regards to the transformer probability of failure. Typically repairs would have to be performed on a number of power transformer components, whilst the major internal components (insulation, core and mechanical enforcement of internal components) cannot be repaired.

As such, no attempt has been made in this report to cover any detailed economic analysis of the viability of rectifying any highlighted issues associated with this transformer but to provide a condition assessment of the “key” parameters for the transformer and what items Powerlink may require to address for future operation.

A summary of the findings is shown in Table 1 but can be further summarised by saying that both transformers have an estimated “as is” residual “unreliable” service life of only about three (3) years, depending on ongoing in-service operating conditions and environment.

TABLE 1

Summary of Estimated Residual Life of “Key” Transformer Parameters

Parameter	Estimated Residual Life		Further Comments
	Transformer T1	Transformer T2	
Anti-corrosion system	Very deteriorated, up to 3 years	Very deteriorated, up to 3 years	Possible to repair, but costly.
Winding paper life	Some parts of paper have reached the end of life.	Some parts of paper have reached the end of life.	Calculated average DP_V =290. Lowest DP_V = 200 for both transformers. Damage will be escalating

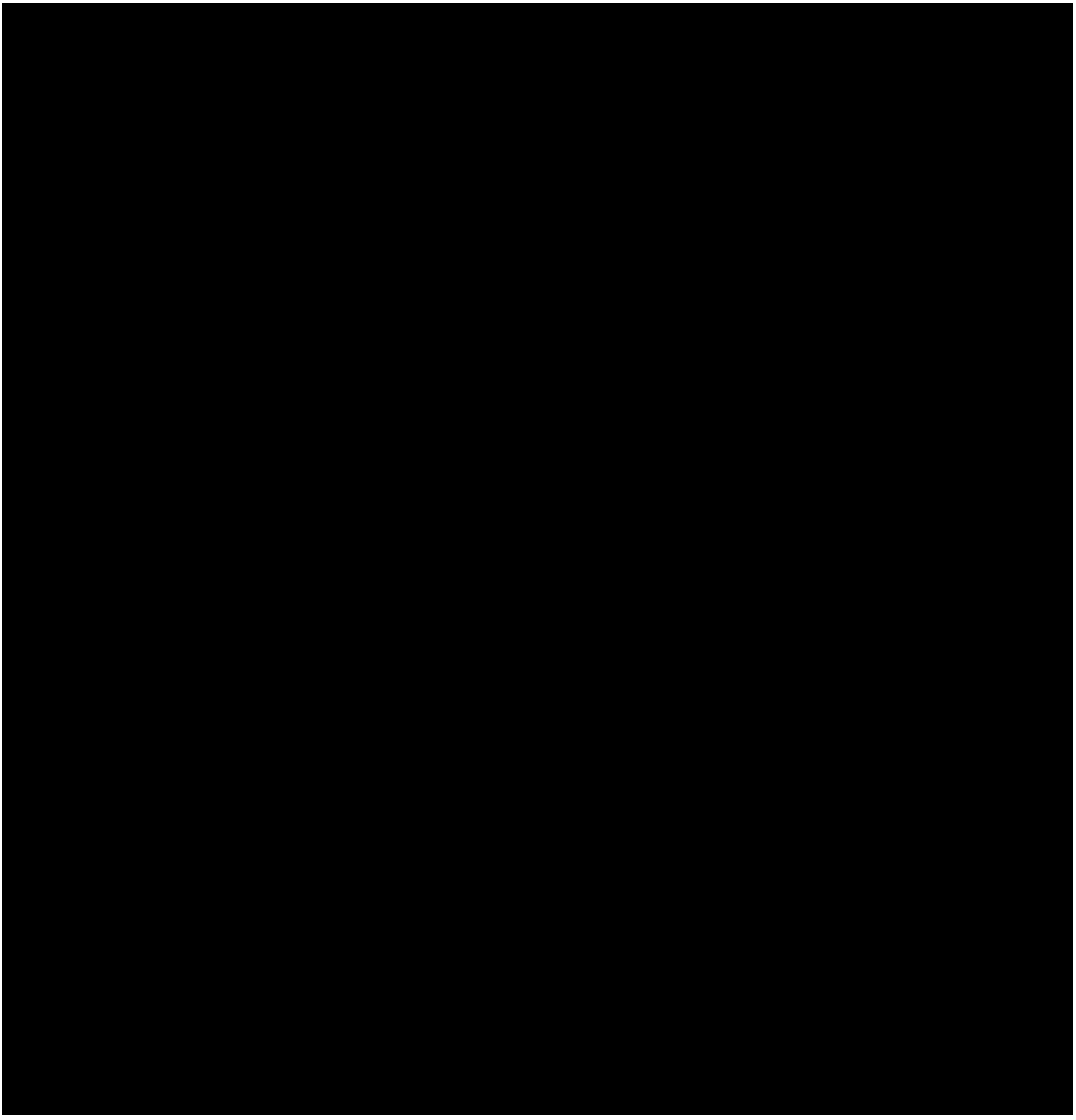
			due to high acidity levels.
Winding mechanical stability	Cannot be assessed accurately, but is questionable due to design and exposure.	Cannot be assessed accurately, but is questionable due to design and exposure.	Old clamping structures design, lowering of DPv & moisture exchange.
External HV OIP 132kV bushings	Max 3 years, test data already provide indication of condition deterioration.	Max 3 years, test data already provide indication of condition deterioration.	Presently at / exceeded OEM limit of degradation. These OIP bushings have exceeded their predicted design life. Subject to test results, it is highly likely that some will fail next test and therefore some or all of these bushings may need to be replaced in the next 3-5 years.
Insulating Oil	Maximum 3 years with significant risk.	Maximum 3 to 4 years	T1 oil considered to be at end of life now. T2 oil considered to be close to end of life.
Radiators	Maximum 3 years	Maximum 3 to 4 years	Oval tubes / bottom header likely to start leaking soon.
Repairs to leaking gaskets.	Required now	Required now	Significant oil leaks visible now.
OVERALL RESIDUAL LIFE	**Estimated 3 years**	**Estimated 3 years**	

To expand upon a few aspects summarised in Table 1, it should be noted that the mentioned HV and LV terminal bushings are well past their predicted design life, with the HV bushings already showing increases in capacitance of up to 20%, well past the 10% replacement point. Replacement of the HV bushings and the LV bushings which are of similar age is not recommended for a few reasons, namely;

- Expending in the order of one third of a million dollars to purchase and install the new replacement bushings when the transformer oil and paper insulation is already at end of life does nothing to improve the reliability or life expectancy of the transformer.
- Because the insulating paper on the bushing leads has poor mechanical strength, the physical movement of the leads that would be necessary for bushing replacement could cause a loss of paper insulation off the lead in a location of high electrical stress. This could in turn cause an internal electrical fault.
- The residual mechanical stability / clamping pressure of the windings is highly questionable due to the significant loss of cellulose (paper) mass. This makes the transformers very susceptible to failure due to through fault.

An oil change for either transformer is not recommended since this would not assist the already degraded winding paper and the vacuuming process required for oil filling could also cause damage to the existing winding paper.

In short, both transformers should be classified as having a low level of in-service reliability.



Planning Statement – Garbutt Transformer Assessment

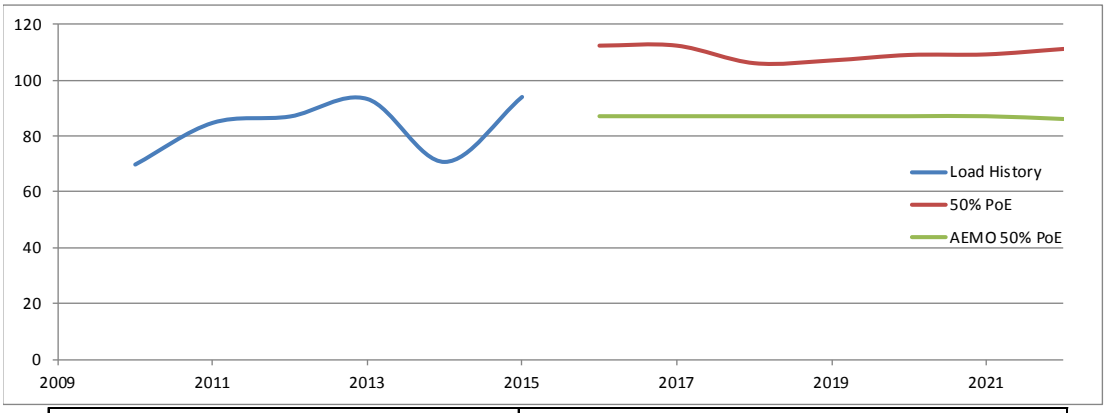
Recommendation: *It is recommended that transformers 1T and 2T be replaced with two transformers at end of life.*

Purpose: The purpose of this paper is to determine the transformation capacity forecast for the Garbutt substation.

Background: Garbutt Substation was commissioned in the 1970's to reinforce the Townsville 66kV network. At establishment, 2 x 70MVA 132/66kV transformers were installed. The ratings of the transformers are shown below:

Transformer Ratings (MVA)	**1T**	**2T**
Normal Cyclic	71	71
Emergency Cyclic	82	82
2hr Short Term	94	94

The historic and forecast loadings for T046 Garbutt (66kV) are shown in Figure 1. Note that as Garbutt is an injection point into a meshed 66kV network, the load under contingency is supported by the surrounding substations at Dan Gleeson, Townsville South and Townsville East.



	Load History						50% PoE Forecast						
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
MVA	70	85	87	93	71	94	112	112	106	107	109	109	111
AEMO MVA							87	87	87	87	87	87	86

Figure 1: Historic and Forecast loads for T046 Garbutt

Latest condition information indicates that 1T and 2T are approaching their end of life, and it is proposed that they be removed from service within the next 10 years.

The following Options were considered to address the EOL of transformers 1T and 2T at Garbutt.

Option: Replace 1T and 2T with two transformers

Under this option the 2 x 70MVA transformers would be replaced with 2 new (minimum 100MVA) 132/66kV transformers.

This option provides adequate N-1 capacity and ensures that Powerlink's reliability obligations under its Transmission Authority are met.

The use of lower rated transformers and network support could be considered if it were to be cost effective.

Recommendation*: This option is recommended on the basis that it meets Powerlink's reliability obligations and likely represents the most economic and efficient investment decision.*

Option: Replace 1T and 2T with one transformer

Under this option it would be proposed to replace the 2 x 90MVA transformers with a single (minimum 100MVA rated) transformer.

This option would not meet Powerlink's obligations under its Transmission Authority, as more than 600MWh would be at risk for the loss of the single transformer

This option, combined with network support, could be considered if it were cost effective. Network support of approximately 10MW / 500MWh would be required to ensure that no more than 600MWh is placed at risk.

This option, with the network support, would provide adequate N-1 capacity and ensures that Powerlink's reliability obligations under its Transmission Authority are met.

Recommendation*: This option could be considered further should network support be viable to meet Powerlink's reliability obligations.*