2018-22
POWERLINK QUEENSLAND REVENUE PROPOSAL

Project Pack - PUBLIC

CP.02462
Ingham South No 1 & 2 Transformer Replacement

Delivering better value

ID&TS - Reset 2017/18-2021/22 Project Proposal for CP.02462 Ingham South No. 1 & 2 Transformer Replacement

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

Contents

1. Executive Summary

Ingham South Substation was re-developed in 2005 to supply the Ergon Energy distribution network in the region 100KM north of Townsville. The original two 132/66kV transformers, T1 and T2 were relocated from the original site. Both transformers are produced in the mid 1960's and are now 50 years of age. Both have been subjected to high cyclic and continuous loads for many years.

Recent analysis of the insulation has revealed that their insulation age is well above the physical name plate age of the units. Consequently there is an increased risk of failure for each transformer due to the condition of the insulation, especially when subjected to repeated 66kV system faults due to increased storm and lightning activity.

The installed 132/66kV capacity at Ingham South is 2 x 34 MVA transformers, which represents a firm substation capacity of 68MVA based on name plate rating.

The objective of this project is to replace the two original 132/66kV transformers at Ingham South with new 40/50/65MVA units by October 2019.

2. Project Definition

2.1 Project Scope

Briefly, the project consists of replacing the existing 2 x 34MVA 132/66kV T1 and T2 transformers at T157 Ingham South with new 132/66kV 40/50/65MVA transformers.

Decommission, remove and dispose of the recovered transformer units.

2.1.1 Transmission Line Works

Not applicable.

2.1.2 T157 Ingham South Substation Works

Design, procure, erect and commission 2 x 132/66kV transformers, including all necessary civil works:

- Procure, supply and install two 40/50/65MVA 132/66kV transformers, each with tertiary winding for connection to station service transformer, on load tap changer and cooling facilities;
- Replace transformer noise walls, transformer blast wall and transformer foundations;
- Replace existing T1 132/66kV transformer with a new 40/50/65MVA transformer;
- Reconnect local supply to new T1 transformer and commission;
- Replace existing T2 132/66kV transformer with a new 40/50/65MVA transformer;
- Reconnect local supply to new T2 transformer and commission;
- Upgrade 66kV underground cables and cable ceiling ends / cable terminations;
- Decommission old T1 and T2 transformer, and recover and dispose of decommissioned transformer units;

- Modify protection, automation and communication systems as necessary to accommodate the new transformers;

2.2 Major Scope Assumptions

- 132kV strung bus connections and surge arrestors are suitable for reuse;
- 132kV TF bay plant equipment achieves load rating compatible with new transformer ratings. A desktop review has been performed to look at the bay ratings, however this did not look at the age or condition of the existing plant;

2.3 Scope Exclusions

- Upgrade of 132kV TF bay plant equipment

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	N/A
	Telecommunication Design	Powerlink
Construction	Earthworks Construction	SPA Contractor
	Civil Construction	SPA Contractor
	Electrical Construction / Installation	SPA Contractor
	Transformer Delivery and Install	Transformer Manufacturer
Testing	Substation Testing – FAT	MSP/Ergon energy
	Substation Testing – SAT	MSP/Ergon Energy
	Substation Testing – Cut-Over	MSP/Ergon Energy
	Telecommunication Testing	MSP/Ergon Energy

3.4 Proposed Sequence of Works

3.4.1 Project Schedule

To meet the required commissioning date of October 2019 full project approval will be required by 30th June 2017.

High Level Schedule

- Project Approval : 30th June 2017
- Order 1st Transformer : July 2017
- Order 2nd Transformer : Jan 2018
- Design Complete : Jan 2018
- SPA Construct contract awarded : March 2018
- Construction : May 18 - June 2019
- Test/commissioning : Sept/Oct 2018 & August/Sept 2019
- Final decommissioning/Tidy up : Sept/Oct 2019
- Project Completion : 31st Oct 2019

3.4.2 Project Staging

Major project stages of the project are considered to be:

Stage	Description/Tasks
1	Non outage prep work
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

Preliminary outage advice from Network Operations has indicated that outages of each transformer will be available to allow in situ replacement. Feeders 7388 & 7133 need to remain in service to supply the Ingham load when each transformer is replaced one at a time. Victoria Mill helps with the Ingham load, therefore, replacement of these transformers ideally would be carried out during the crushing season (June-Oct).

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.

Based on the outage advice received it is likely that the construction start date would need to be brought forward or the completion date extended to allow the outages to occur in the crushing season (June-Oct). The dates have not been adjusted for this estimate however when more detailed planning occurs this will need to be considered.

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 31/10/2019 at 2.5% per year plus labour revisions, for CP.02462 Ingham South No.1 & 2 Transformer Replacement is as follows:

CP.02462 Quotation in $ AUD	Base Levels	Escalated to Compln.	Comment (Costs @ Base Levels)
T157 Ingham South Substation	[redacted]	[redacted]	Replace the existing 2 x 34MVA 132/66kV T1 and T2 transformers at T157 Ingham South with new 132/66kV 40/50/65MVA transformers. Decommission, remove and dispose of the recovered transformer units. Replace transformer noise walls, transformer blast wall and transformer foundations. New transformer oil separation tank. New 66kV underground cables, sealing ends. Repair access road. Modify protection and automation systems.
Project Management	[redacted]	[redacted]	
Qleave			
Other Costs			
TOTAL QUOTE (EXCL RISKS AND OFFSETS)	**6,582,153**	**7,069,348**	
Offsets Estimate	**0**	**0**	
TOTAL QUOTE (INCL OFFSETS)	**6,582,153**	**7,069,348**	
Climate	[redacted]		
Construction			
Design			
Risk Estimate	**395,000**	**395,000**	
TOTAL QUOTE (INCL RISKS AND OFFSETS)	**6,977,153**	**7,464,348**	

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.02462 Asset Disposal Table. Values current at 30th June 2016

Functional Loc.	Description	Asset	Subnumbe	Book val.	% Disposal	Disposal Value	Currency
T157-T01-1TRF	1 TRANSFORMER	105576	0	84,689.01	100%	84,689.01	AUD
T157-T02-2TRF	2 TRANSFORMER	105577	0	84,689.16	100%	84,689.16	AUD
					Total	169,378.17	AUD

6. References

Document name and hyperlink (as entered into Objective)	Version	Date
Project Scope Report	1.0	June 2015
Estimate Detail	3.0	Jan 2016

Transformer T1 & T2 Condition Assesment
T157 Ingham South 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	11/05/2015	**Date of site visit**	30/01/2015		

Date	Version	Objective ID	Nature of Change	Author	Authorisation
11/05/2015	1.0	A2187075	Original		
05/01/2016	2.0	A2200643	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

Transformers T1 and T2 are both General Electric designs and are 49 and 50 years old respectively 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 condition of the 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 these transformers but to provide a condition assessment of the “key” parameters for the transformer and what may need to be actioned if the transformers are to be operational for a further 3 years.

A summary of the findings is shown in Table 1. This suggests that the transformers have an estimated reliable “as is” residual service life of about three years. To keep the transformers much beyond this would likely require significant expenditure on repairs which may not be economic. Although these repairs would result in increased transformer availability, the transformer probability of failure would not change.

As a minimum, some routine maintenance would be required over the next few years to try and slow down existing oil leaks, prevent others from forming and fix localised corrosion. This may include additional radiator panel oil leaks which may develop where the oval radiator panel tubes enter the bottom radiator header.

Both transformers should be classified as having a low level of in-service reliability but not due to the internal oil and cellulose insulation condition.

TABLE 1

Summary of Estimated Residual Life of "Key" Transformer Parameters

Parameter	Estimated Residual Life		Further Comments
	Transformer T1	Transformer T2	
Anti-corrosion system	Completely failed.	Completely failed.	Extensive corrosion over main tank.
Winding paper residual life	26 years	13 years	Calculated average DP_V =500 Lowest DP_V = 400.
Winding mechanical stability	Cannot be assessed accurately, but is considered questionable due to design and exposure.	Cannot be assessed accurately, but is considered questionable due to design and exposure.	Old clamping structures design, lowering of DPv & moisture exchange.
External OIP 132kV bushings	Estimated 3 years with increased risk	Estimated 3 years with increased risk	These SRBP bushings have exceeded their predicted design life. Subject to test results, it is reasonable to expect that some or all of these bushings may need to be replaced in the next 3-5 years.
Insulating Oil	Estimated 10 years	Estimated 10 years	Was processed as part of the transformer being relocated to Ingham South in 2005.
Radiators	Failing	Failing	Oval tubes / headers are one of the big problem areas.
Repairs to leaking gaskets.	Required now	Required now	The cooler bank has a more immediate need.
OVERALL RESIDUAL LIFE	**Estimated 3 years**	**Estimated 3 years**	**For as is condition. Estimated case to maintain reliability.**

2. INVESTIGATION:

A comprehensive on-site inspection of T1 and T2 was performed on the 30th January 2015 and the major findings which may impact its serviceability and future cost of ownership are discussed in this report. The substation Operating Diagram is shown in the figure 1.

Planning Statement – Ingham South Transformer Assessment

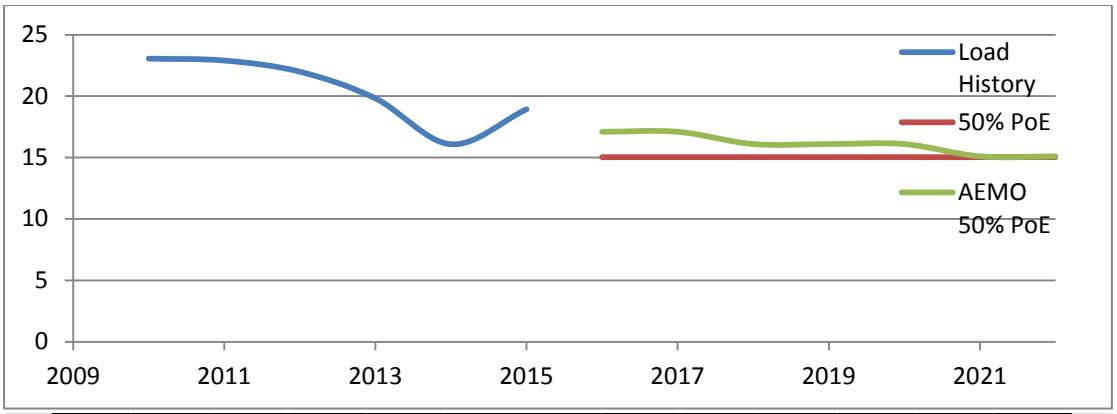
Recommendation: *It is recommended that transformers 1T and 2T be replaced with two transformers at end of life.*

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

Background: Ingham South Substation was established in 1965 With 2 x 35MVA 132/66kV transformers. The ratings of the transformers are shown below

Transformer Ratings (MVA)	**1T**	**2T**
Normal Cyclic	35	35
Emergency Cyclic	39	39
2h Short Term	40	40

The historic and forecast loadings for T157 Ingham South are shown in Figure 1.



	Load History						50% PoE Forecast						
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
MVA	23	23	22	20	16	19	15	15	15	15	15	15	15
					AEMO MVA :		17.1	17.1	16.1	16.1	16.1	15.1	15.1

Figure 1: Historic and Forecast loads for T157 Ingham South

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 Ingham South.

Option: Replace T1 and T2 with two transformers

Under this option the 2 x 35MVA transformers would be replaced with 2 new (minimum 20MVA) 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 reliability obligations and represents the most economic and efficient investment decision.*

Option: Replace T1 and T2 with one transformer

Under this option it would be proposed to replace the 2 x 35MVA transformers with a single (minimum20MVA rated) transformer.

This option would not meet Powerlink's obligations under its Transmission Authority. During 2014/15 greater than 600MWh would be at risk for the loss of the single transformer under this scheme.

This option, combined with network support, could be considered; however network support of up to 18MW would need to be available within 2 days to ensure no more than 600MWh of energy is placed at risk.

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

Recommendation*: This option should not be considered further on the basis that it does not meet Powerlink's reliability obligations.*