January 2026

Powerlink 2027-32 Revenue Proposal

Project Pack

CP.03149 Newlands Transformer 1 Life Extension

Project Status: Unapproved

Network Requirement

The Newlands 132/66kV Substation, approximately 130km west of Mackay, was established in 1983 to augment supply to the expanding coal mining operations in the area and is an essential bulk supply point. The Powerlink owned assets include a 132kV switchyard, with two 132/66kV transformers. Transformer T1 is a 40 MVA 132/69/11 kV unit manufactured in 1982 and has been in service for 42 years.

The 36-Year Electrical Condition Assessment determined that Transformer 1's insulation system was in acceptable condition to support a further 10 years of service. Further to this, a comprehensive condition assessment was carried out in 2024. This assessment concluded that refurbishment work is required in order to extend the operational life of this transformer by 10 years. [1].

Powerlink's 2025 Central scenario forecast confirms there is an enduring need to maintain electricity supply into the Newlands area. The removal of the 132/66kV transformer 1 at Newlands Substation would violate Powerlink's N-1-50MW/600MWh Transmission Authority reliability standard [2].

Powerlink is currently unaware of any feasible alternative options to minimise or eliminate the load at risk at Newlands but will, as part of the formal RIT-T consultation process, seek non-network solutions that can contribute significantly to ensuring it continues to meet its reliability of supply obligations.

Recommended Option

As this project is currently 'Unapproved', project need and options will be subjected to the public RIT-T consultation process to identify the preferred option closer to the time of investment.

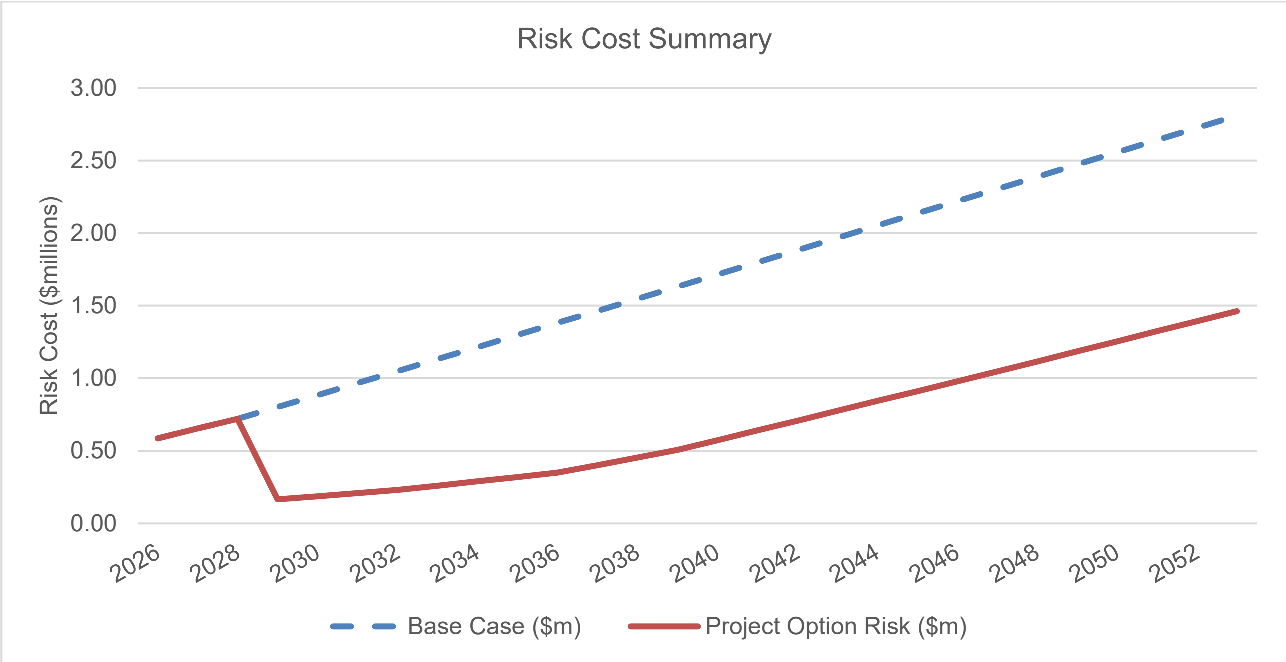
The current recommended option given the expected remaining life of the insulation systems is to invest in life extension works for transformer 1 at Newlands by 2028 [3].

Options considered but not proposed include:

- Do Nothing – rejected due to non-compliance with reliability standards and safety obligations;
- Decommission Transformer 1 – rejected due to non-compliance with reliability standards under the credible contingency of loss of the remaining transformer;
- Replace Transformer 1 with a new 132/66kV transformer – rejected due to expected higher overall cost; and
- Non-network option – no viable non-network options have been identified at this time.

Figure 1 shows the current recommended option reduces the forecast risk monetisation profile of the Newlands Substation Transformer 1 from around $0.7 million per annum in 2028 to less than $0.2 million from 2029 [5].

Figure 1 – Annual Risk Monetisation Profile ($ Real, 2025/26)



Cost and Timing

The estimated cost to undertake life extend transformer 1 at Newlands substation is $3.0m ($2025/26) [4].

Target Commissioning Date: June 2028.

Documents in CP.03149 Project Pack

Public Documents

1. T069 Newlands Transformer T1 Condition Assessment Report
2. CP.03149 Newlands Transformer 1 Life Extension – Planning Statement
3. CP.03149 Newlands Transformer 1 Life Extension – Project Scope Report
4. CP.03149 Newlands Transformer 1 Life Extension – Concept Estimate
5. CP.03149 Newlands Transformer 1 Life Extension – Risk Cost Summary Report

T1 Transformer Condition Assessment T069 Newlands Substation

Asset Category	Power transformers	**Author**	[redacted]	**Authorisation**	[redacted]
Activity	Condition assessment - primary substation plant, power transformers.				
Reviewed by:	[redacted]	Review Date:	05/09/2024		
Document Type	Report	**Team**	Substation Strategies		
Issue date	06/09/2024	**Date of site visit**	19/06/2024		

Date	Version	Objective ID	Nature of Change	Author	Authorisation
06/09/2024	1.0	A5626247		[redacted]	

Note: *Where the indicator symbol ☼# is used (# referring to version number), it indicates a change / addition was introduced to that specific point in the document. If the indicator symbol ☼# is used in a section heading, it means the whole section was added / changed.*

IMPORTANT: - As this condition assessment is a snapshot in time and subject to the accuracy of the assessment methodology and ongoing in-service operating environment, the recommendations and comments in this report are valid for 3 years from the date of the site visit stated above.

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1 SUMMARY

A condition assessment was performed on a 30/40 MVA,132/69/11kV transformer T01 installed at T069 Newlands substation which has been in service for 42 years to determine its residual service life and any issues that may need to be considered. Although no internal active part inspection was performed, the assessment utilized the results of electrical tests performed within “36 years assessment” in 2023. These tests provided insights into the condition of the core, existence of winding displacement and/or winding deformation.

This report does not attempt to cover any detailed economic analysis of the viability of rectifying the highlighted issues associated with these transformers but provides a condition assessment of the “key” parameters for these transformers and reinvestment recommendations for their future service.

1.1 Recommendation

Based on the comprehensive investigation and condition assessment of transformer T01 at Newlands Substation, two strategic options were evaluated to determine the optimal investment approach: **replacing the transformer within five years** or **life extension for an additional 10 years**, **pushing the replacement to 2037**.

Given the acceptable condition of the transformer insulation system, as concluded by the “36-Year Electrical Condition Assessment”, and considering the lead time required for a replacement, it is advised to undertake the following essential works within 3 years and reassess the condition and the needs for transformer replacement (most likely to be required by the end of 2037).

- **Bushing Replacement:** Replace HV, LV, and neutral bushings within three years to mitigate operational and safety risks. Given that the bushings are 42 years old and the aging mechanism beyond 40 years is uncertain, it is recommended to conduct electrical testing on the bushings annually until they are replaced. This will help mitigate the risk of unpredictable failures and the associated operational and safety risks.
- **Transformer Control Cubicle Replacement**: Replace the control cubicle to prevent functional and safety risks, and to ensure compliance with AS3000 Standard.
- **Oil Leak Remediation**: Fix the existing oil leaks that do not require lowering the oil in the main tank below the top of the windings. Additionally, all accessible leaking butterfly valves should be either replaced or removed.
- **Silica Gel Breathers:** Replace the OLTC PVC breather with a Powerlink approved OLTC breather that has a minimum of 7.5kg of desiccant.
- **OLTC Maintenance:** Address corrosion on OLTC fasteners and linkage. Upgrade the OLTC control cubicle to ensure compliance with AS3000 Standard (for example, install electrical safety barriers to cover the live terminals).
- **Oil Containment System:** Clean and seal the oil bund and ensure the oil separation tank is fully functional.

Transformer Replacement Strategy: Provided the above-mentioned issues are addressed within the next three years, this transformer is expected to have an estimated remaining service life of an additional 10 years (post 2027). This timeline allows adequate opportunity to re-assess condition and the need to replace the transformer most likely by the end of 2037.

1.2 INVESTIGATION:

A comprehensive on-site inspection of T01 was performed on the 19th of Jun 2024 and any major findings which may impact the transformer’s serviceability are discussed in this report. The substation Operating Diagram is shown in Figure 1.

It can be seen from the substation operating diagram shown above that this T01 transformer is operated in parallel with T02 transformer with the bus section circuit breakers closed.

T02 transformer at this site has failed in 2008 and was replaced with system spare transformer 100MVA. The original T02 was sister unit to T01 and was found to have compromised clamping system.

[redacted]

Figure 1- T01 Newlands 132/66kV Substation Operating Diagram.

2 T069 Newlands TRANSFORMER T01

2.1 Identification Details:

Transformer T1 details are shown below.

- Manufacturer - HYUNDAI
- Contract - H404/81
- YOM - 1982 (42 years)
- Commissioned 1983
- Ratings - 30/40 MVA ONAN / OFDAN
- Voltage - 132/69/11kV
- Serial No - T22027
- SAP Equipment No- 20008341
- Breathing System: Free Breathing
- Tap changer – Type- M Reinhausen OLTC Model No. 1 3XMI 301 110/D 10191G, Serial No. 88733, SAP Equipment No. 20013769.
- OLTC counter reading = (37275) on the 19th of Jun 2024
- Bushings-HV: Oil insulated porcelain housed MICAFIL, WTXF 145-650/800, 145 kV 800 AMP
- Bushings-LV: Oil insulated porcelain housed MICAFIL, WTXF 73-325/800, 72.5 kV 800 AMP
- Bushings-Neutral: Oil Impregnated Paper (OIP), G.E, 17B400BB, 400A, 29 kV (L-G)

This transformer has s separate cooler bank.

2.2 Onsite Inspection:

2.2.1 Anti-corrosion System:

The maintenance records from September 2023 indicated that surface corrosion on the transformer main oil tank and conservator had been addressed. However, the recent onsite inspection (refer to Figures 3-11) revealed multiple areas where corrosion persists, with severity ranging from Grade 1 to Grade 3. Notably, the conservator tank (see Figures 3-5) exhibits more extensive corrosion than previously documented in 2023. This raises concerns about whether the conservator tank was effectively painted or if the applied protective coating has failed to mitigate the corrosion. The extent and progression of the corrosion, as shown in the close-ups (Figures 6-11), suggest that the anti-corrosion measures may have been inadequate or that the paint application did not adhere properly, necessitating further investigation and potentially more robust remediation efforts. Additionally, Figure 11 reveals a missing bolt at the top lid of the transformer, and protruding gasket. Replacing and tensioning the bolt without replacing the gasket poses a significant risk. The old gasket is likely stuck to both flanges, and any compression could compromise this adhesion, potentially resulting in an oil leak. Therefore, it is not recommended to carry out corrective work before replacing the transformer.

Figure 2- Conservator Tank with Visible Corrosion (June 2024)

Figure 3- Conservator Tank Prior to Painting (2023)

Figure 4- Close-up of Conservator Tank Corrosion

Figure 5- Touch-Up Paint Marks on Transformer

Figure 6- Grade 2 Corrosion and paint flake on Oil Valves

Figure 7- Corrosion and paint deformation

Figure 8- Bolts on Transformer Main Oil Tank with Grade 1 Corrosion

Figure 9- Corrosion and paint flake

Figure 10- Corrosion on Transformer Components (Grades 1 to 3)

Whilst corrosion is present on many parts of this transformer, it is primarily associated with replaceable and repairable components. These issues are unlikely to pose a significant risk until the transformer is replaced.

2.2.2 Oil Leaks:

- The maintenance records indicate a history of ongoing oil leaks, particularly from several valves, top flanges on radiator fins, the ground-level receiver, and weeps from flanges on top of the transformer and the drain/fill valve of the conservator. These leaks have not been fixed and are currently being monitored by the maintenance service provider.
- The transformer oil has been topped up on multiple occasions to maintain operational levels:
    - In June 2007, 300 litres of oil were added.
    - In May 2020, the main conservator tank and tap changer conservator were topped up to raise the oil level from 10 degrees to 25 degrees.
    - In 2022, 250 litres of oil were added to the transformer.
- During the recent site visit inspection, various active oil leaks were observed, including those from the oil cooler banks receiver pipe flanges, as well as multiple leaks from the conservator tank, main oil tank, and associated pipework, as indicated in Figures 12-22 below.
- Several gaskets on the transformer lids, and flanges show signs of deformation and cracking, which are likely to exacerbate oil leakage over time if not addressed.
- Given the transformer age and insulation condition, it is recommended to fix oil leaks that do not require lowering the oil level below the top of the winding, extending the transformer's operation for an additional 10 years until its replacement. Additionally, all accessible leaking butterfly valves should be either replaced or removed. To address all oil leaks, the transformer oil would need to be completely drained and all gaskets replaced which is not recommended.

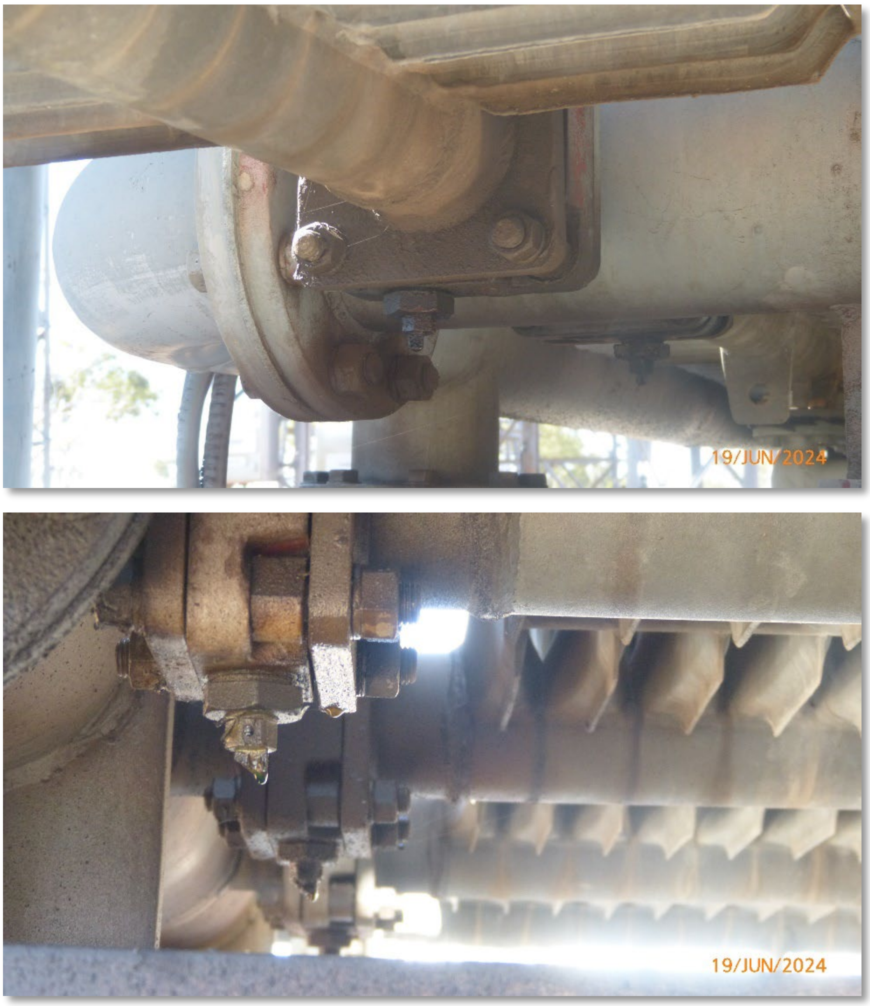


Figure 11- Oil Leak from Transformer Cooler Flanges

Figure 12- Oil on Transformer Surface from Active Leaks

Figure 13- Oil Leak from Drain/Fill Flange

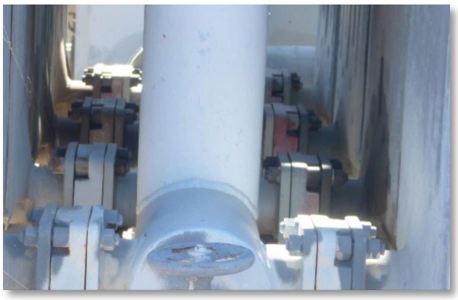


Figure 14- Oil Leak from Oil Cooler Bank Receiver Flanges

Figure 15- Oil Leak from Oil Isolation Valve

Figure 16- Oil Leak from Transformer Lid

Figure 17- Oil Leak from Cooler receiver pipe flange

Figure 18- Oil on Transformer Bund Floor

Figure 19- Oil Leak on Cable Tray Showing Corrosion

Figure 20- Flange with Significant Gasket Deformation

Figure 21- Flange Gasket Deformed and Deteriorated

2.2.3 Silica Gel Breathers:

The maintenance records indicate that the main transformer PVC breather was replaced in 2019 by the new Powerlink standard breather, while the OLTC breather is still the retrofit solution made from PVC pipe, which is recommended to be replaced with a Powerlink approved OLTC breather that has a minimum of 7.5kg of desiccant if the transformer is to be refurbished.

The main transformer breather had an issue with the sealant, which was fixed in 2020, and the desiccant was replaced in 2021.

During Jun 2024 site inspection, the silica gel in both the main breather and the OLTC breather appeared to be in good condition with no signs of saturation or contamination. All seals and connections associated with the breather systems were found to be intact and leak-free. The mounting brackets and hardware for the breathers were checked for corrosion or mechanical damage and found to be secure and in good condition.

Figure 22- OLTC Breather with Ergon Retrofit PVC Solution

Figure 23- Main Silica Gel Breather in Good Condition

2.2.4 Drycol Breather Control Box

The transformer was initially equipped with a Drycol breather, which was mounted on the side of the conservator. Subsequently, this breather was removed and replaced with a conventional desiccant breather. However, the control box for the Drycol breather remains affixed to the radiator bank.

Please note that the oil stains visible in the accompanying photographs are believed to originate from a leak or spilt oil during sampling at the ground-level gas receiver and the associated pipework/valves located above.

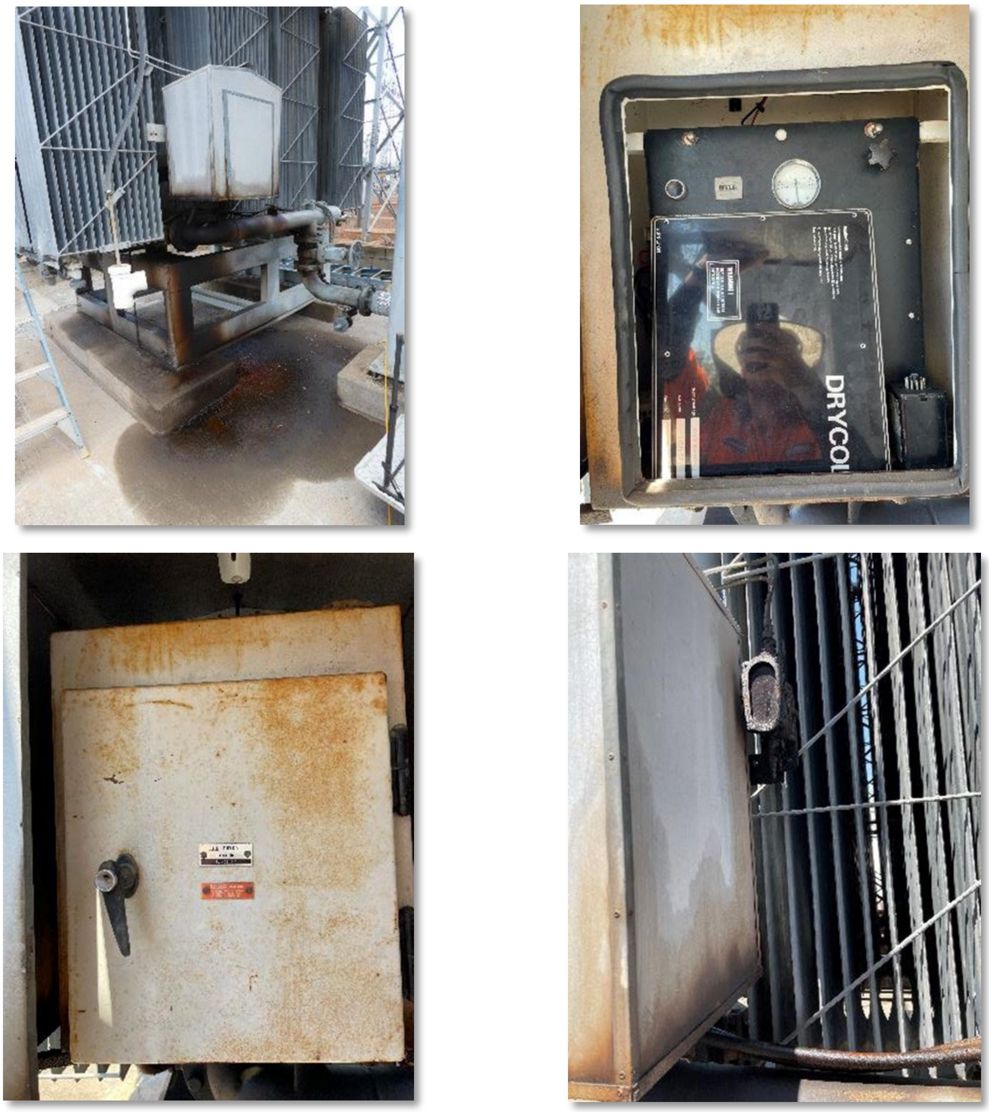


Figure 24- Drycol Breather Control Box

2.2.5 Temperature Indication Instruments:

Figure 25- WTI and OTI (Installed in Shared Control Cubicle)

The temperature indication instruments were replaced in 2004 as part of project OR.00113. According to maintenance records, there have been no reported issues with temperature monitoring since the replacement. Additionally, during the site visit, all temperature sensors and associated wiring were visually inspected for physical damage, corrosion, and secure connections, with no issues detected.

2.2.6 Control Cubicles:

2.2.6.1 Protection and Cooling Control Cubicle

The site inspection of the protection and cooling control cubicle revealed significant concerns regarding the condition of the control panel. The following observations were made:

- The control cubicle door exhibits minor corrosion (refer to Figure 27).
- There is evidence of oil ingress into the control panel, likely resulting from nearby leaks. This has led to contamination of control components, terminal blocks, and wiring within the cubicle (refer to Figures 28 and 29). Such contamination poses a risk to the functionality and reliability of the control systems.
- The control components, terminal blocks, and wiring inside the panel are visibly contaminated with insulating oil, which, despite its dielectric properties, could lead to compromised insulation integrity over time, increased maintenance requirements, and potential operational safety risks if not properly managed (see Figure 29). In addition it is not compliant to the AS3000.

Figure 26- Minor Corrosion on Control Cubicle Door

Figure 27- Oil-Contaminated Control Components

Figure 28- Terminal Blocks and Wiring with Oil Contamination

To mitigate the risks associated with oil contamination and to ensure compliance with current safety standards, it is recommended that the control cubicle be replaced.

2.2.6.2 On-load Tap Changer Control Cubicle

During the site visit, the tap changer control cubicle door could not be opened for an internal inspection. However, the OLTC control cubicle was inspected by OSD in October 2023, and the findings are outlined in report OSD-PSS-CA-009:

- All electrical connections within the control cubicle were observed to be in good condition
- No signs of oil leaks from the gearbox or motor drive mechanism
- There is no electrical safety barrier Installed to cover the live terminals. It is required to upgrade the OLTC control cubicle to ensure compliance with AS3000 Standard.

Figure 29- OLTC Control Cubicle in Good Condition

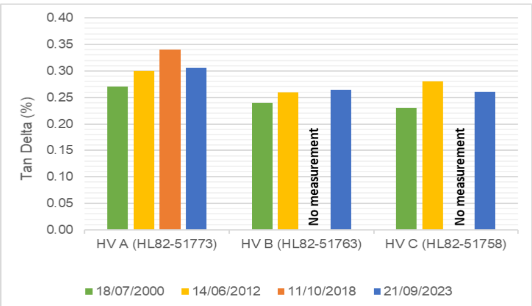
2.2.7 Transformer Bushings:

The high voltage (HV) and low voltage (LV) bushings installed on the transformer are oil-impregnated paper (OIP) bushings housed in porcelain, and they have now been in service for 42 years.

2.2.7.1 High Voltage Bushings:

According to standard maintenance practices, the bushing capacitance and dielectric loss angle (DLA) for the HV bushings are monitored every six years. SAP records indicate that the last test was conducted in 2023; however, there is a lack of recorded test results in SAP for Phases B and C beyond the year 2000, and for Phase A beyond 2018.

Although the 2000 test results recorded in SAP indicate that all HV bushings exhibited DLA values exceeding 20 mrad—significantly above the 7 mrad defect level necessitating bushing replacement as defined by Powerlink ASM-SPE-A2675743. The trend in Figure 31 for the historical test results reveals that these values were incorrectly entered in SAP and require correction. The results demonstrate that the measured Tan-δ and C1 capacitance values are consistent with previous measurements and fall within the acceptable criteria for high voltage OIP bushings. Further details on the test results are discussed in section 2.4.3.



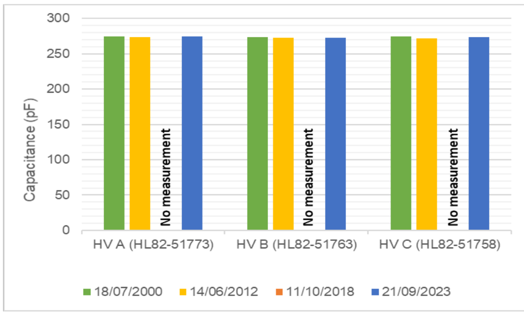


Figure 30- H.V Bushings Tan-δ and C1 capacitance Historical Test Results

2.2.7.2 Low Voltage Bushings:

The LV bushings, like the HV bushings, are also OIP bushings in porcelain housings and have been in service for the same duration of 42 years. Only the 2000 DLA test records are available in SAP. Similar to the HV bushings, the LV bushing test records have been incorrectly entered in SAP, showing DLA values for the three phases recorded as 26, 28, and 28 mrad, when they should be 2.6, 2.8, and 2.8 mrad, respectively, as recorded in the last testing carried out in 2023.

The results demonstrate that the measured Tan-δ and C1 capacitance values are consistent with previous measurements and fall within the acceptable criteria. Further details on the test results are discussed in section 2.4.3.

2.2.7.3 Neutral Bushing:

The original General Electric Type U neutral bushing from 1982 remains in service. A series of capacitance and dielectric loss factor tests were performed in 2023 to assess the integrity of this bushing, as documented in report OSD-PSS-CA-009. The 50Hz dissipation factor at 10 kV was measured at approximately 0.56%, which falls within the action level for OIP bushings as per the Powerlink Substation Maintenance Specification (A2675743). However, frequency sweep tests returned high dissipation factors at lower frequencies, a typical indication of moisture ingress and compromised insulation.

As the bushing is only used for the neutral-earth connection, it is not subject to significant voltage stress and is therefore at a lower risk of failure.

2.2.7.4 Recommendations:

The manufacturer recommends a service life of 25 years for OIP bushings. Given the advanced service age (42 years) of both the HV and LV bushings, along with the signs of aging and potential moisture ingress in the neutral bushing, it is recommended that all these bushings be preventively replaced within the next three years. Additionally, an increased monitoring frequency of once per year should be adopted until the bushings are replaced.

2.2.8 On- Load Tap Changer (OLTC):

Maintenance records show that the tap changer has been operating reliably. Only four maintenance notifications were recorded in March 2023, concerning the tap changer's operation counter, tap position, and alarms for low and high tap ranges. These issues were addressed during the six-yearly service completed by the OEM in September 2023, aligned with the scheduled shutdown.

The OLTC underwent a detailed visual inspection by OSD during the scheduled shutdown in September 2023, as documented in report OSD-PSS-CA-009. The OLTC *was found to be in very good condition* considering its age, with the following observations:

- *No signs of oil leaks from the gearbox or motor drive mechanism*
- *Minor corrosion and previous red-oxide treatment on the drive linkage*
- *Corrosion on various fasteners for oil surge relays and diverter lids*

Figure 32- OLTC Drive Linkage with Minor Corrosion

Figure 31- Corrosion on Fasteners for Oil Surge Relays and Diverter Lids

2.2.9 Transformer T1 Foundation and Bunding

The transformer civil works is approximately 41 years old. The bund walls have been constructed with concrete core filled blockwork and is assessed as being in a functional condition. The oil bund is formed by a concrete apron and concrete block walls.

Figure 33- Blockwork Bund Wall

The bund is in a good condition and should provide a functional service for another 10 years, however, it is recommended that an inspection be performed in 10 years' time. The apron and plinths were in good condition. The bund apron allows drainage into a flame trap drain pit that flows into the oil containment tank. The flame trap appeared intact and functional but contained no water.

Ongoing oil leak evidence was observed in in the bund which is related to the transformer age.

Figure 34- Apron Crack

All joints have been sealed with an “Abelflex” type sealant. As the sealant is subjected to UV degradation, i.e. hardening and shrinkage, the following recommendations are advised based on observations:

- A sealant sub surface probing inspection be conducted to determine remaining flexure properties and side wall adherence. Removal and replaced is advised where found to be deteriorated.
- All sealant holidays are to be removed, prepared and replaced
- Bund wall and apron interface sealant found to be degraded needs to be lightly mechanically ground to remove dirt, sealant and loose material in preparation for application of new sealant.

Figure 35- Flame Trap

2.3 Oil and Insulation Assessment:

A desktop assessment was performed on the oil laboratory test data for this transformer and the following information is derived.

2.3.1 Oil Quality:

The oil was last tested for polychlorinated biphenyl (PCB) content in 1992, and no PCBs were detected. As a result, the transformer is classified as "PCB-free." It is recommended to conduct another PCB test before undertaking any major works.

Additionally, the oil tested negative for the presence of corrosive sulphur, indicating that there is no current risk of copper corrosion.

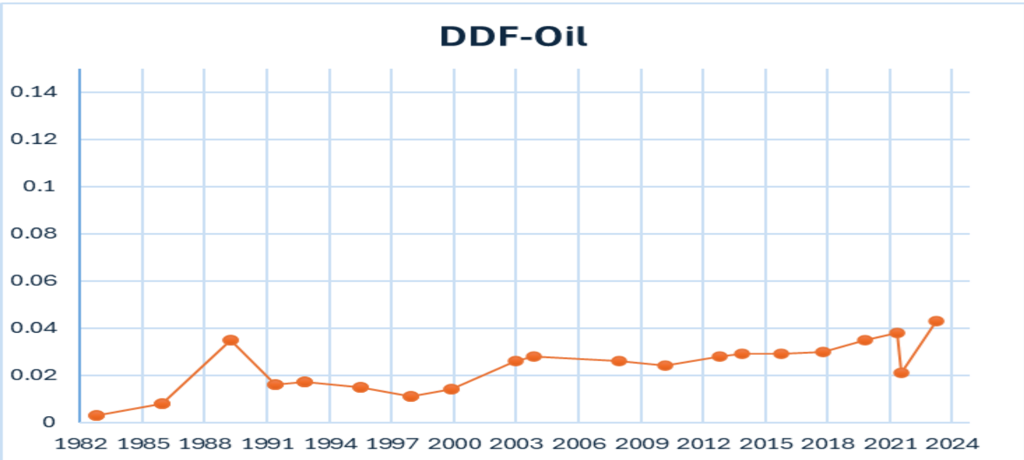


Figure 36– Oil DDF trend

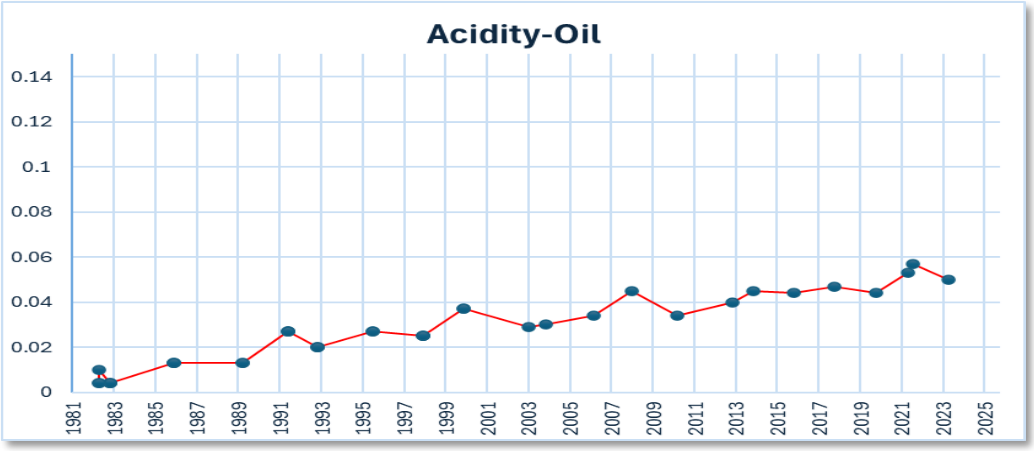


Figure 37 – Oil Acidity Measurements

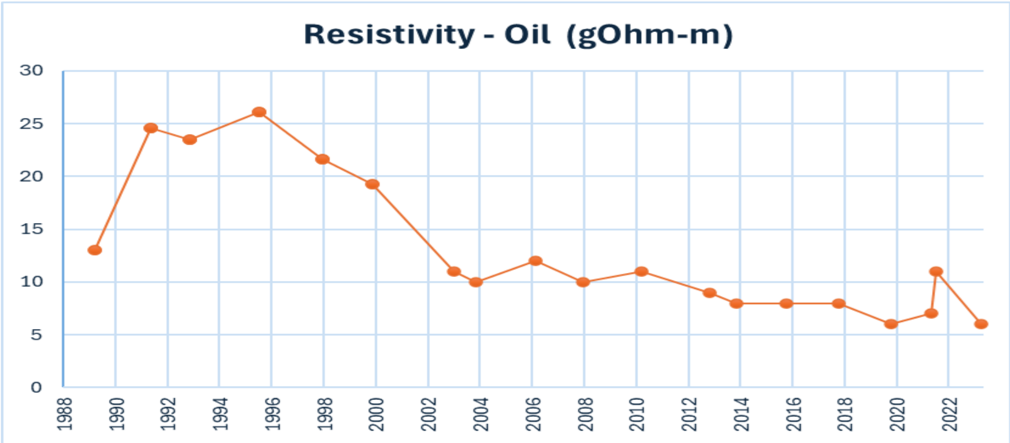


Figure 38- Oil Resistivity Trend

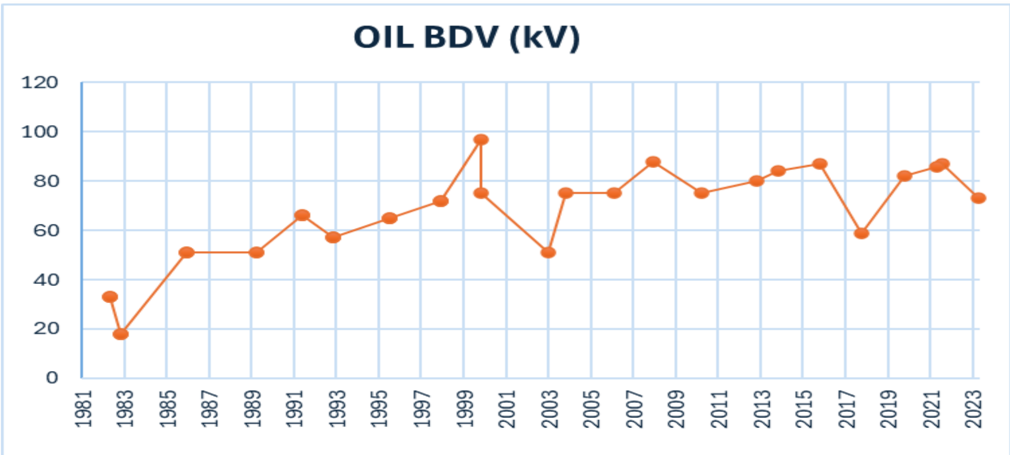


Figure 39 – Oil Breakdown Voltage

The oil quality still within acceptable limits, with no significant signs of deterioration. Both the oil acidity and resistivity measurements indicate that the oil is still in good condition.

Assuming all measurements are adjusted to 20°C (unlikely before 2000) and using the SD Myers tool, Figure 41 shows the moisture in solid insulation. Measurements from 2000-2024 show moisture content below 4%, except for 2018, which recorded 5.4%

likely due to the oil sampling process. The moisture content in solid insulation is trending up from 1.3% in 2014 to 3% in 2024.

As detailed in Section 2.4.1.1, the SD Myers method estimates the average moisture content in the solid insulation to be approximately 2.2%, with a range spanning 1.5% to 3.2%. However, the Omicron DIRANA test conducted in 2023 provides a more accurate measurement, indicating a moisture content of 0.8%. Based on the transformer's age and the initial moisture content during its manufacturing in the 1980s, it is likely that the cellulose insulation currently contains between 1% and 1.5% moisture by dry weight. Moisture levels should continue to be monitored as the transformer ages to assess the need for drying interventions in the future.

Figure 42 below shows Powerlink's approach towards managing changing moisture levels within transformers insulation.

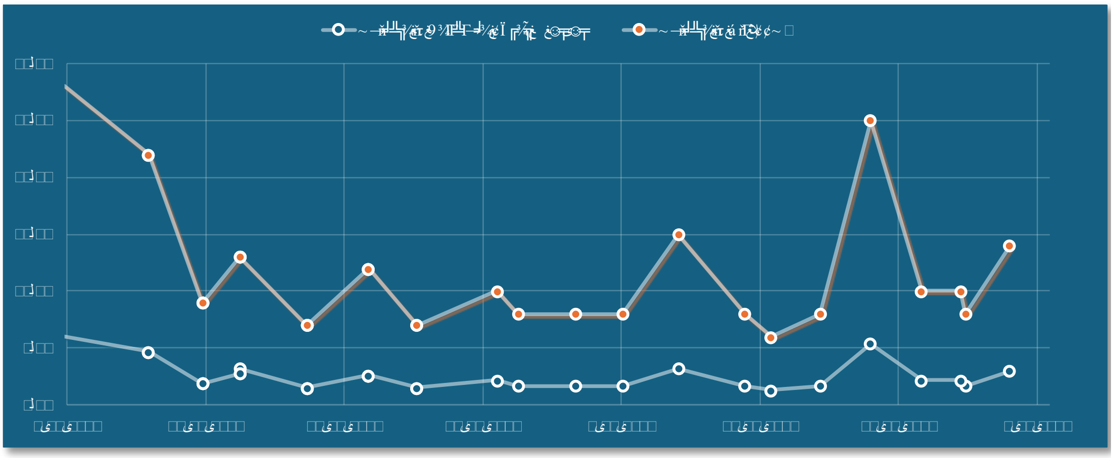


Figure 40- moisture in solid insulation- SD Myer

Moisture % in Cellulose Insulation by Dry Weight	Powerlink's Policy for Recommended Action
≤ 0.5	Take no action. Insulation is considered dry.
1% - 2%	Acceptable but correlate moisture with nameplate age, loading history, leaks, breather maintenance etc.
2% - 3%	Consider if planning for a suitable period to dry insulation before it reaches about 3% is viable / economic.
3% - 4%	In need of drying if economic. Entering the "*At Risk*" zone.
5% - 6%	There is a risk of internal flashover under certain rapid temperature variations. Can also lead to insulation gassing problems.
7%	Failure is imminent.

Figure 41- Powerlink's guideline for managing moisture levels in power transformer insulation

2.3.2 Transformer Loading

This transformer can operate in two cooling modes: ONAN (Oil Natural Air Natural) and ODAN (Oil Directed Air Natural).

The peak loading on the 132kV side of this transformer from January 30, 2007, to September 4, 2024, was 29.7 MVA, recorded in May 2012. This peak load is within the nameplate rating for the ONAN cooling mode.

The average loading during this period was 8.24 MVA, which corresponds to 21% of the nameplate rating in ODAN mode and 20.6% of the normal cyclic loading (40 MVA). This indicates light loading throughout the transformer's service life, with the exception of the T2 transformer shutdown period (from October 6, 2008, to October 31, 2008), during which the average load reached 24.8 MVA.

This light loading is consistent with the relatively high calculated Degree of Polymerization (DP) value of the insulating paper, indicating good insulation condition and extended service life.

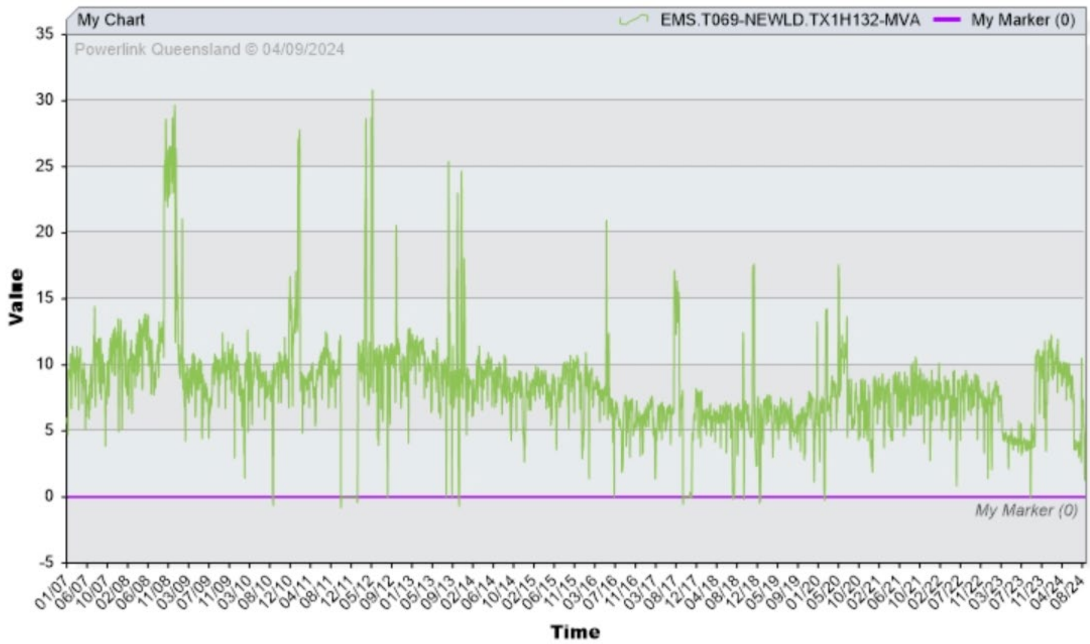


Figure 42 – Transformer 132 kV Loading History

2.3.3 Dissolved Gas Analysis:

There are a few “stand-out” aspects to note from the oil dissolved gas analysis (DGA) test data and they are as follows:

- Apart from a spike in methane and ethane values in the 1990 sample, which were still within acceptable limits, key dissolved gas concentrations have remained very low—less than 5 ppm—and steady from 1991 to 2024. This stability indicates that the transformer does not show signs of internal degradation or faults.

- Carbon monoxide and carbon dioxide levels are within the accepted limits (350 ppm and 2500 ppm respectively) as per IEEE C57.104 standards, indicating normal aging of the insulation paper.

- Hydrogen level in oil show normal values within the normal limits over the service life.

- Hydrogen levels in the oil have consistently remained within normal limits.

- The transformer’s main oil tank and on-load tap changer (OLTC) oil tank each have separate conservators, ensuring no oil exchange between the two tanks. This separation isolates the OLTC oil from the main transformer oil, preventing cross-contamination or impact on the DGA results of the main oil tank.

- The minor traces of acetylene dissolved gas found in the main tank oil (ranging from 0.4 to 1.0 ppm) can be attributed to a couple of factors:
  - Minor oil leakage from the OLTC diverter switch compartment. According to Reinhausen, the original equipment manufacturer (OEM), these compartments are not entirely oil-tight. They are prone to minor leaks through the cylinder wall terminal seals.
  - It can be difficult to clean the Laboratory GC column following the testing of an oil sample that had very high levels of acetylene. As a result, the first oil sample to be tested following a very contaminated sample may pick up minute traces of gases that are very soluble in oil and difficult to remove.

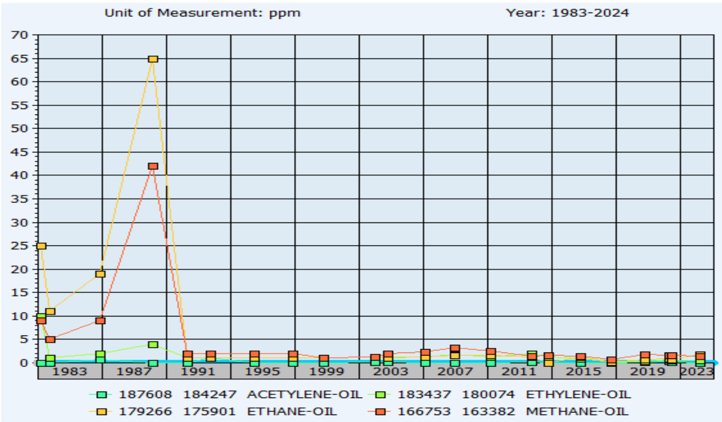


Figure 43- Key Dissolved Gases in Oil

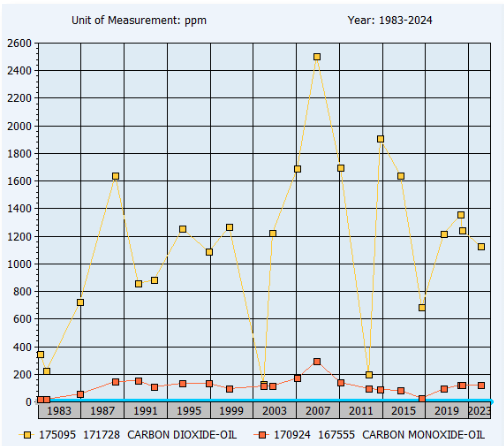


Figure 44- CO & CO2 in Oil

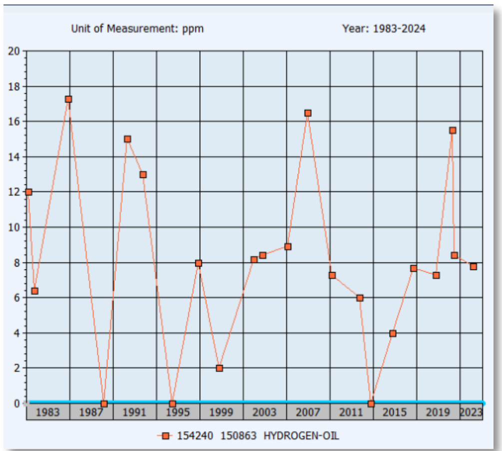


Figure 45- H2 in Oil

2.3.4 Moisture in Insulation:

This is covered in Section 2.3.1 of this report. Percentage of the average moisture in the insulation was assessed to be to be below 2% by dry weight using measured moisture in oil samples and DIRANA test. It is likely that this is due to the good condition of the silica gel breather and being the transformer operated at low load during most of its service life.

2.4 "36-Year Electrical Condition Assessment":

In 2023, an assessment of the dielectric condition of the transformer and its bushings was conducted, as detailed in OSD-PSS-CA-009. The results from this testing are summarized below.

2.4.1 Insulation System

2.4.1.1 Moisture Assessment

The main transformer insulation system was evaluated for moisture content using the Omicron DIRANA, revealing a moisture level of 0.8%. This indicates that the paper insulation is in a dry state. The calculated moisture level is significantly lower than the estimated range of 2% to 3% using the SD Myers method, which is based on the moisture content in the oil. Given the transformer's age and the initial moisture content during its manufacturing in the 1980s, it is likely that the cellulose insulation currently contains between 1% and 1.5% moisture by dry weight.

2.4.1.2 Insulation Resistance

Insulation resistance and polarization index (PI) tests were conducted to assess potential insulation deterioration or failures in the windings or core earthing. The results indicate satisfactory insulation performance across all measured parameters.

2.4.1.3 Winding Capacitance & Dissipation Factor

The winding capacitance and dissipation factor (DF) tests revealed a maximum DF of approximately 0.33% at 50Hz, which falls within the standard limits defined by IEEE C57.152. The capacitance measurements for the primary and tertiary windings were 4,563 pF and 7,463 pF, respectively. Overall, the results indicate that the insulation system is still in good condition.

2.4.2 Winding and Core

2.4.2.1 Short Circuit Impedance

According to IEEE/IEC standards, a deviation limit of 3% from the nameplate values is deemed acceptable. The recorded results in OSD-PSS-CA-009 indicate a maximum deviation of 0.8% from the nameplate values, thus falling well within the acceptance criteria.

2.4.2.2 Sweep Frequency Response Analysis (SFRA)

The Sweep Frequency Response Analysis (SFRA) revealed good phase correlation in HV-LV, LV-N, and tertiary terminals despite the lack of previous SFRA traces for comparison.

2.4.2.3 Turns Ratio

The turns ratio test, which measures the effective voltage transformation between windings, was performed across all taps. The primary to secondary winding ratio deviated by less than 0.04% from the nameplate values, well within the acceptable limit of 0.5%, indicating healthy windings with no signs of shorted or open turns. Similarly, the primary to tertiary winding ratio showed deviations of less than 0.12% from the nameplate values. These results confirm that all turns ratio measurements are within acceptable limits, demonstrating the transformer’s windings are in good condition.

2.4.2.4 Magnetising Current

The magnetising current test exhibited typical characteristics for a three-limb core transformer, with A and C phases showing results within a 5% variance of each other, and the B phase approximately 30% lower. No core faults, shorted turns or winding parts were detected, affirming that the transformer's windings and core are in optimal condition.

2.4.2.5 DC Winding Resistance

The DC winding resistance test results for HV, LV, and tertiary windings showed minimal deviations from the factory acceptance test (FAT) values, confirming the integrity and uniformity of the transformer windings. Specifically, the HV winding deviations ranged from 0.81% to 3.15%, LV winding deviations were less than 0.46%, and tertiary winding deviations were below 0.58%. All results are within acceptable limits as per IEEE C57.152-2013 standards.

2.4.3 Bushings

2.4.3.1 High Voltage Bushings

The measured Tan-δ and C1 capacitance values closely match previous measurements and fall within the acceptable range for high voltage OIP bushings, as specified by Powerlink Substation Maintenance Specification (A2675743).

2.4.3.2 Low Voltage Bushings

The analysis indicates that the measured C1 capacitance and dissipation factor (Tan-δ) of the low voltage bushings are consistent with historical data across all phases. These parameters fall well within the acceptable limits for high voltage Oil Impregnated Paper (OIP) bushings, as stipulated by the Powerlink Substation Maintenance Specification (A2675743).

2.4.3.3 Neutral Bushings

The 50Hz dissipation factor at 10 kV was measured to be approximately 0.56%, which falls within the action levels for OIP bushings as per the Powerlink Substation Maintenance Specification (A2675743). Additionally, the frequency sweep results returned high dissipation factors at lower frequencies, indicating potential moisture ingress and compromised insulation integrity.

2.5 Estimated Residual Life of Transformer:

2.5.1 Anti-corrosion System Life

Whilst corrosion is present on many parts of this transformer, it is primarily associated with replaceable components. This corrosion, while concerning, does not currently pose a direct threat to the overall service life of the transformer.

2.5.2 Insulation Life

For the Newlands transformer T01, the insulation age was calculated to be approximately 18 years based on a DP value of 758, which is significantly below its actual service age of 41 years. However, it is important to note that localized areas of the winding, particularly hot spots, may have lower DP values ranging between 700 and 560, indicating an effective insulation age closer to 26 years.

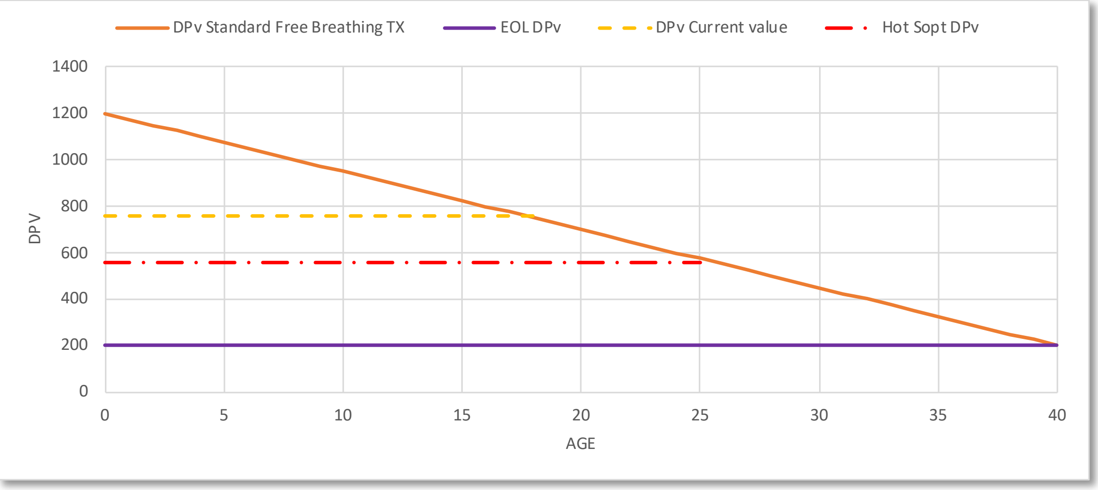


Figure 46- Calculation of cellulose insulation age using a 2-FAL in Oil

Since no actual paper samples were taken for this assessment, the DP value was derived from the dissolved furans in oil. The estimated trend is depicted in Figure 52, considering an approximation for the hot spot, which assumes that the furan data only represents an average of the overall cellulose insulation mass.

The DP value is highly contingent on various operational parameters, including temperature, load, and moisture. Given the average loading of the T1 transformer at merely 8.24 MVA (21% of its rated capacity), the anticipated service life based solely on paper aging substantially exceeds the theoretical design life.

Assuming consistent operating conditions, the trend analysis indicates that the transformer retains an estimated 15 years of remaining insulation service life.

2.5.3 Mechanical Life

Although no internal active part inspection was performed, several electrical tests were conducted to evaluate the condition of the core, winding geometry, and potential winding deformation. These tests revealed no abnormalities.

No internal inspection was conducted on this transformer to assess the condition of the core and coils directly. Without removing the main tank lid in the field or factory, which is necessary to access all clamping points, it is impossible to inspect the outer windings for displacement, twisting, or tilting, or to verify block stability and residual clamping pressure. The financial implications of such an intrusive inspection would be substantial and difficult to justify given the transformer's age.

The fault level at Newlands is calculated to be 4.0kA at the 132 kV voltage level and slightly over 14kA at the 11 kV voltage level.

The transformer experienced a through fault on October 6, 2008, caused by a turn-to-turn short on the C phase low voltage winding of Transformer 2.

What can be stated about the mechanical stability of the windings is as follows.

(a) The top clamping structure for this old transformer design is known to be unacceptable by today's standards.

(b) Even with an estimated 0.8% to 1.5% moisture content in the internal winding insulation system partially migrating in and out of the clamped structure due to changes in transformer load, there will be some loss of clamping pressure due to the phenomenon shown in the figure below. It is realised that load changes are not normally as sharp as in the diagram, but the overall cyclic effect is the same.

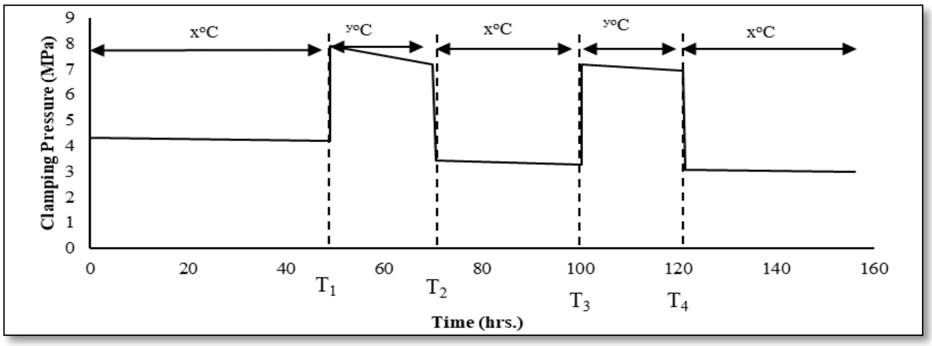


Figure 47- Example of the effect of cyclic compression on a clamped insulation structure

(c) Research into the loss of winding clamping shows that for the winding radial spacers alone, where the biggest axial thicknesses exist within the winding, a change of 1.5% moisture produces a change in clamping pressure of about 1%. Given the relatively low estimated moisture content in the insulation of around 1.5%, it shouldn't significantly reduce the axial clamping force of the winding structure.

(d) A decrease in the internal cellulose insulation mass, reflected by the DP value dropping from 1100 to 759, will lower the winding's residual clamping pressure, though the exact extent of this reduction is currently uncertain.

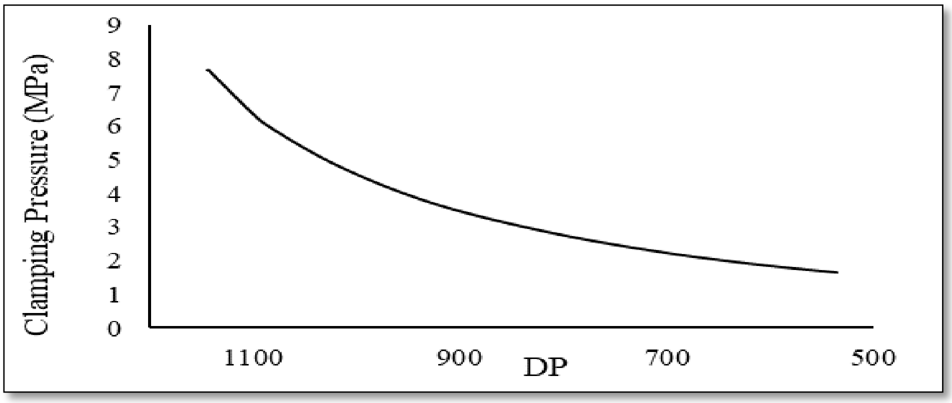


Figure 48- Example of the effect of loss of DPv on Clamping Pressure

(e) Low Voltage Leakage Reactance and Sweep Frequency Response Analysis (SFRA) Did not detect any winding displacements.

(f) In summary, due to these factors, the ability of the core and coils (active part) to withstand through faults has reduced, particularly if subjected to significant close in through faults. The electromechanical forces exerted on the winding structure due to periodic through faults often have a cumulative effect similar to the impact of moisture and temperature cycling.

Considering these aspects, the mechanical stability and through fault withstand capability of the winding structure would be classified as medium risk. In this condition, the structure could potentially last for a minimum of 10 more years unless a significant event, such as multiple through faults, occur.

2.6 Transformer Maintenance Cost:

The corrective maintenance trend for Newlands Transformer 1 (T01) shows a gradual increase in corrective maintenance cost over time, with significant escalations observed from 2019 onwards. In the early 2000s, corrective maintenance interventions were relatively infrequent, primarily involving minor emergency repairs such as pump failures, oil leaks, and tap changer condition-based maintenance.

From 2019 onwards, there has been a marked increase in corrective maintenance costs. This rise is not primarily due to aging-related transformer failures. Key interventions during this period included the replacement of silica gel breathers (upgraded from non-standard PVC to standard breathers) in 2019, an investigation of a transformer trip caused by a 66kV Shutdown Device failure in 2022, and condition-based maintenance of the tap changer along with electrical testing for condition assessment in 2023.

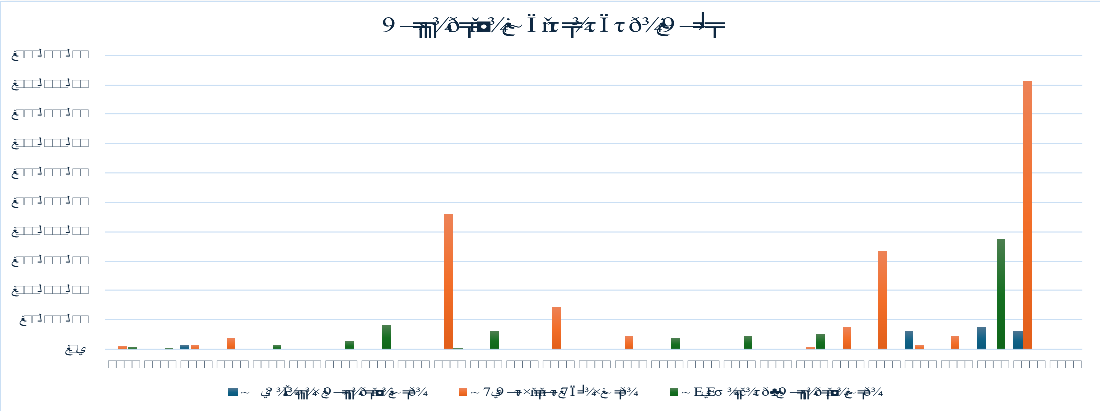


Figure 49– Transformer Corrective Maintenance Cost

2.7 Transformer Future Operation Requirement

Until recently, the forecast peak load for Newlands was approximately 25MVA, distributed across both transformers. However, with the closure of the mine, the peak load is now expected to be less than 15MVA, with the average load around 10MVA.

Despite this reduction, both transformers are still needed, although a lower rating might be acceptable.

2.8 References:

OSD-PSS-CA-009 T069 Newlands 1 Transformer Condition Assessment	A5317801
Condition Assessment Photos	K:\SubstationPhotos\Newlands\Newlands-20240619

Planning Report	**9 October 2025**
Title	CP.03149 Newlands Transformer 1T Life Extension
Zone	North
Need Driver	Emerging operational and safety risks arising from the condition of the 132/69/11kV 1T transformer
Network Limitations	Newlands 1T 132/69/11kV transformer is necessary to meet Powerlink Queensland's N-1-50MW/600MWh Transmission Authority reliability standard.
Pre-requisites	None

Executive Summary

Newlands 1T transformer is 30/40 MVA, 132/69/11kV unit. It was manufactured by Hyundai in 1982 and has been in operation for 42 years.

The Central scenario load forecasts confirm there is an enduring need to maintain electricity supply into the Newlands area. The removal or reconfiguration of Newlands Substation due to condition of 1T transformer would violate Powerlink's N-1-50MW/600MWh Transmission Authority reliability standard.

The preferred network solution for Powerlink to continue to meet its statutory obligations is to undertake life extension works on 1T to extend the service life of the transformer by 10 years.

Table of Contents

1. Introduction

T069 Newlands Substation was established in 1983. It is a 132/66/11kV bulk supply point supplied via two radial 132kV feeders and supplies 40MVA transformer 1T and 100MVA transformer 2T.

Transformer 1T is a 30/40 MVA, 132/69/11kV unit from HYUNDAI, built in 1982. After 42 years of service, it has surpassed its standard 40-year design life for free-breathing transformers.

The geographic location of the Newlands Substation is shown in Figure 1.

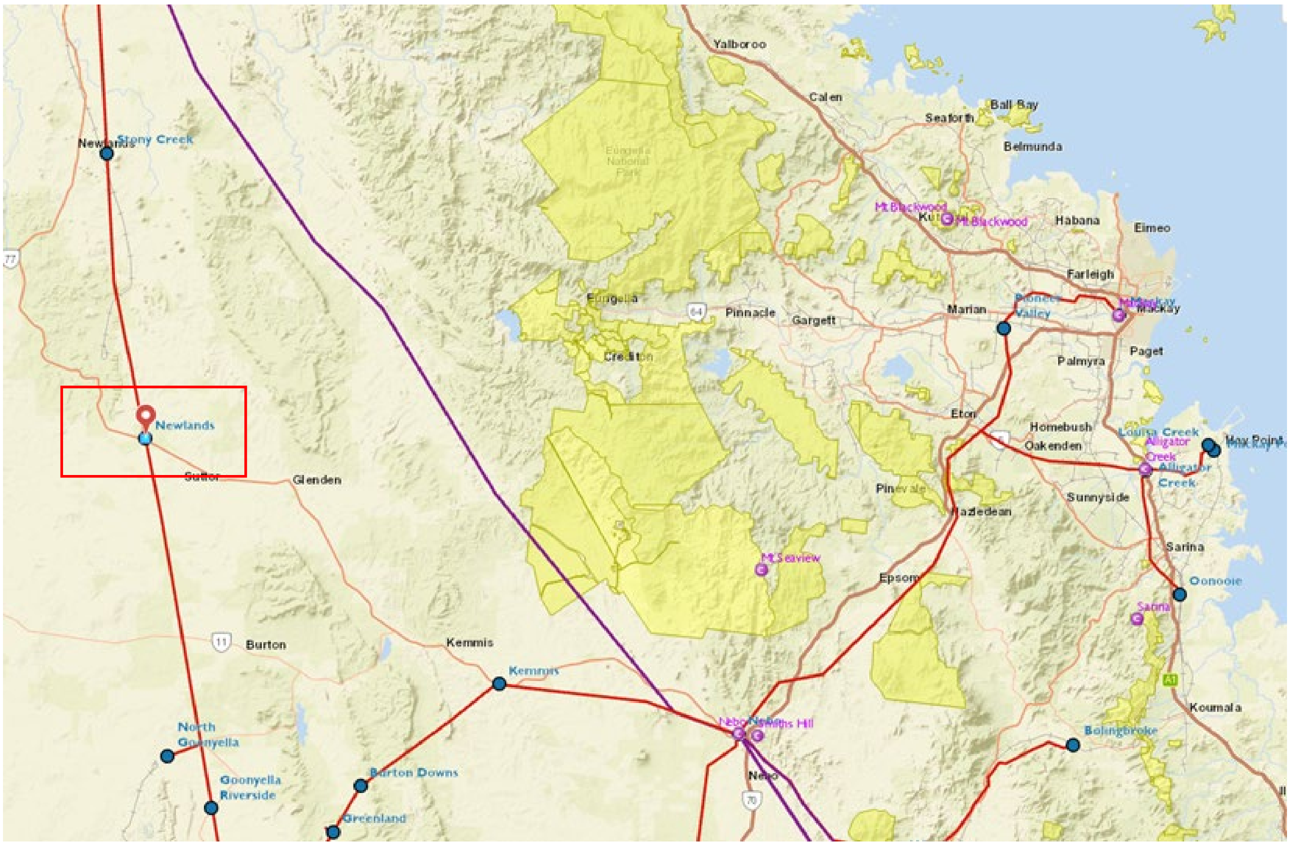


Figure 1. Newlands substation

The 36-Year Electrical Condition Assessment found Transformer 1's insulation suitable for another decade of service. However, a 2024 assessment determined that refurbishment is necessary to extend its life by an additional 10 years.

2. Newlands Substation configuration

The substation consists of:

1. Two 132/33kV feeders from Collinsville North and Goonyella Riverside substations
2. A 132kV switchyard which provides 2 x 132/66/11kV transformer bays.

Figure 2 shows the single line diagram of Newlands Substation and the proposed scope of works.

[redacted]

Scope of works under CP.03149

Figure 2. Newlands Substation Operational Diagram

This report assesses the impact that removal of the at-risk transformer would have on the performance of the network and Powerlink's statutory obligations. It also establishes the indicative requirements of any potential alternative solutions to the current services provided by the transformer.

3. Newlands Demand Forecast

The Newlands Substation supplies Ergon Energy and industrial and mining customers in the Newlands region.

Newlands contains a mining load that ceased operations within the past two years but is anticipated to resume production. This is reflected in the forecast demand data.

The historical and forecast Newlands Substation load is shown in Figure 3.

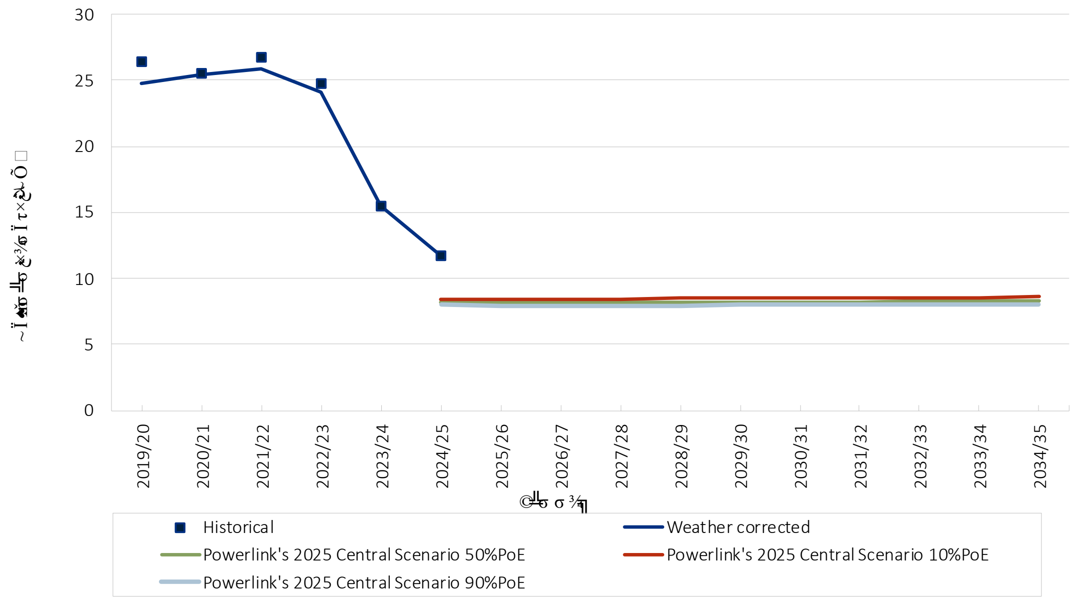


Figure 2. Newlands maximum demand forecast

The historical load duration curves from 2020 are shown in Figure 4.

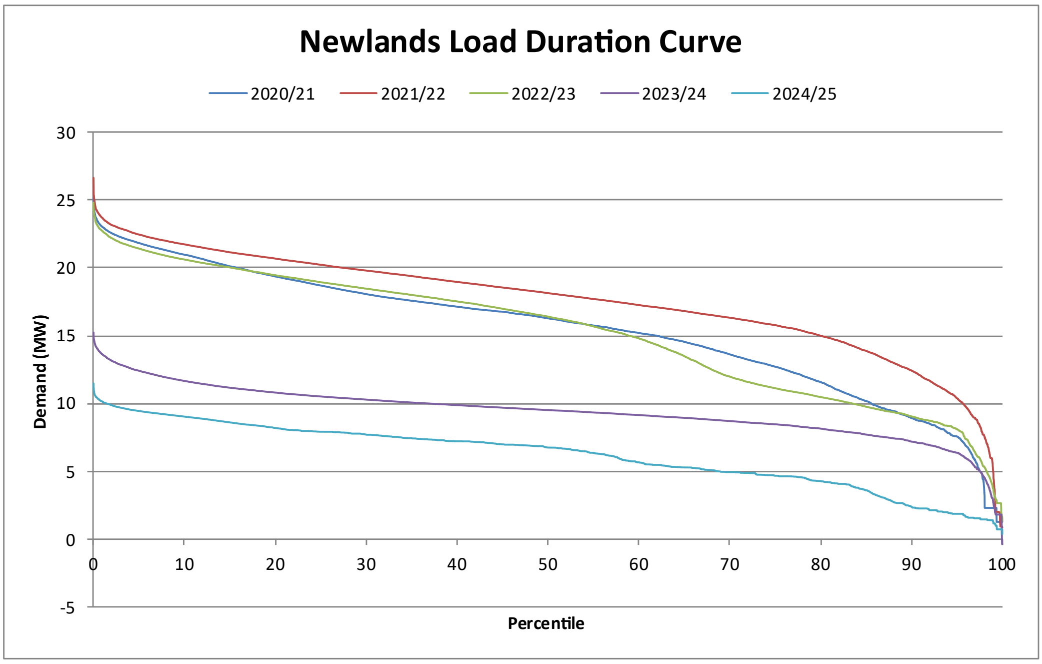


Figure 3. Newlands Load Duration Curve

4. Statement of Investment Need

The Newlands Substation serves as a critical bulk supply point for the Newlands area.

If no investment is made and 1T retired from service, then following the credible contingency loss of 2T the customer loss of supply would exceed 600 MWh. Additionally, there would be no capacity for maintenance on the remaining transformer, as it would necessitate a supply interruption of up to 18MW for any maintenance activities.

Therefore, retaining Newlands as a two 132/66/11kV transformer substation is necessary to maintain Powerlink's N-1-50MW/600MWh Transmission Authority reliability standard.

5. Network Risk

Table 1 summarises the load and energy at risk if 1T transformer is decommissioned.

If transformer 1T is decommissioned due to aging and condition, and no further investment, Newlands Substation will be left with a single transformer. In the event of a contingency on 2T and considering that the mean time to repair or replace a transformer is 10 to 12 weeks, the 600MWh limit of Powerlink's Transmission Authority will be exceeded.

Table 1. Network Load at Risk

At Risk	Contingency	Metric	2024/25	2024/25 + PV	2034/35	2034/35 + PV
Newlands 66kV	Loss of 132/66kV transformer (1T & 2T)	Max (MW)	11.5	13.1	8.3	8.6
		Average (MW)	6.2	6.6	5.8	5.9
		24h Energy Unserved Max (MWh)	232.8	246.4	179.2	182.3
		24h Energy Unserved Average (MWh)	149.2	159.1	137.9	140.5

6. Non Network Options

The Newlands 132/66/11kV transformers facilitates supply to Ergon Energy in the Newlands area.

To meet the Newlands substation demand, the non-network solution must be capable of delivering up to 10MW and 200MWh per day.

Powerlink is not aware of any Demand Side Solutions (DSM) in the Newlands area. However, Powerlink will consider any proposed solution that can contribute significantly to the requirements of ensuring that Powerlink continues to meet its required reliability of supply obligations as part of the formal RIT-T consultation process prior to project approval.

7. Network Options

7.1 Proposed Option to address the identified need

To address the condition of 1T transformer at Newlands Substation, it is recommended to undertake life extension works on 1T.

This option ensures that reliability of supply and asset condition criteria are met in the Newlands area.

Further details of condition assessment for the Newlands Transformer and their recommendation can be found in Reference 1.

7.2 Option Considered but Not Proposed

This section discusses alternative options that Powerlink has investigated but does not consider technically and/or economically feasible to address the above identified issues and thus are not considered credible options.

7.2.1 Do Nothing

“Do Nothing” would not be an acceptable option as the primary driver (ageing technical life) and associated safety, reliability and compliance risks would not be resolved. Furthermore, the “Do Nothing” option would not be consistent with good industry practice and would result in Powerlink breaching their obligations with the requirements of the System Standards of the National Electricity Rules and its Transmission Authority.

8. Recommendations

Powerlink has reviewed the condition of Transformer 1 in Newlands Substation and transformer porcelain bushings have already breached end of technical service life. It is therefore recommended that life extension works be conducted.

Retaining Newlands transformer will allow Powerlink to continue to meet its required reliability obligations (N-1-50MW/600MWh).

Powerlink is currently unaware of any feasible alternative options to minimise or eliminate the load at risk at Newlands but will, as part of the formal RIT-T consultation process, seek non-network solutions that can contribute to reduced overall investment needs whilst ensuring Powerlink continues to meet its reliability of supply obligations.

9. References

1. T069 Newlands Transformer T1 Condition Assessment Report 2024
2. Project Scope Report - CP.03149 T069 Newlands Transformer 1 Life Extension
3. 2025 Transmission Annual Planning Report (A6049612)
4. Asset Planning Criteria - Framework (ASM-FRA-A2352970)
5. Powerlink Queensland’s Transmission Authority T01/98

Project Scope Report

CP.03149

T069 Newlands Transformer 1 Life Extension

Proposal – Version 1

Document Control

Change Record

Issue Date	Revision	Prepared by	Reviewed by	Approved by	Background
7/04/25	1	[redacted]	[redacted]	[redacted]	

Related Documents

Issue Date	Responsible Person	Objective Document Name
4/03/25	[redacted]	PIF T069 Newlands Transformer-1 Life Extension (A5780371)
6/09/24	[redacted]	T069 Newlands Transformer T1 Condition Assessment Report 2024 (A5626247)

Document Purpose

The purpose of this Project Scope Report is to define the business (functional) requirements that the project is intended to deliver. These functional requirements are subject to Powerlink's design and construction standards and prevailing asset strategies, which will be detailed in documentation produced during the detailed scoping and estimating undertaken by DTS (or OSD), i.e. it is not intended for this document to provide a detailed scope of works that is directly suitable for estimating.

Project Contacts

Project Sponsor	[redacted]
Connection & Development Manager	[redacted]
Strategist – HV/Digital Asset Strategies	[redacted]
Planner – Main/Regional Grid	[redacted]
Manager Projects	[redacted]
Project Manager	TBA
Design Manager	TBA

Project Details

1. Project Need & Objective

T069 Newlands Substation was established in 1983 and serves as a critical bulk supply substation. It is supplied via two radial 132kV feeders, which feed the 132/66/11kV, 40 MVA Transformer (T1) and 132/66/11kV, 100 MVA Transformer (T2).

Transformer T1 is a 30/40 MVA, 132/69/11kV unit, manufactured by HYUNDAI in 1982. Having been in service for 42 years, it has exceeded the typical 40-year design life of a free-breathing transformer.

The 36-Year Electrical Condition Assessment determined that Transformer 1's insulation system was in acceptable condition to support a further 10 years of service. Further to this, a comprehensive condition assessment was carried out in 2024. This assessment concluded that refurbishment work is required in order to extend the operational life of this transformer by 10 years.

The objective of this project is to undertake life extension works on Transformer 1 at Newlands substation to extend the service life of the transformer by 10 years by June 2028.

2. Project Drawing

[redacted]

Scope of works under CP.03149

Figure 1: Newlands Substation Operational Diagram

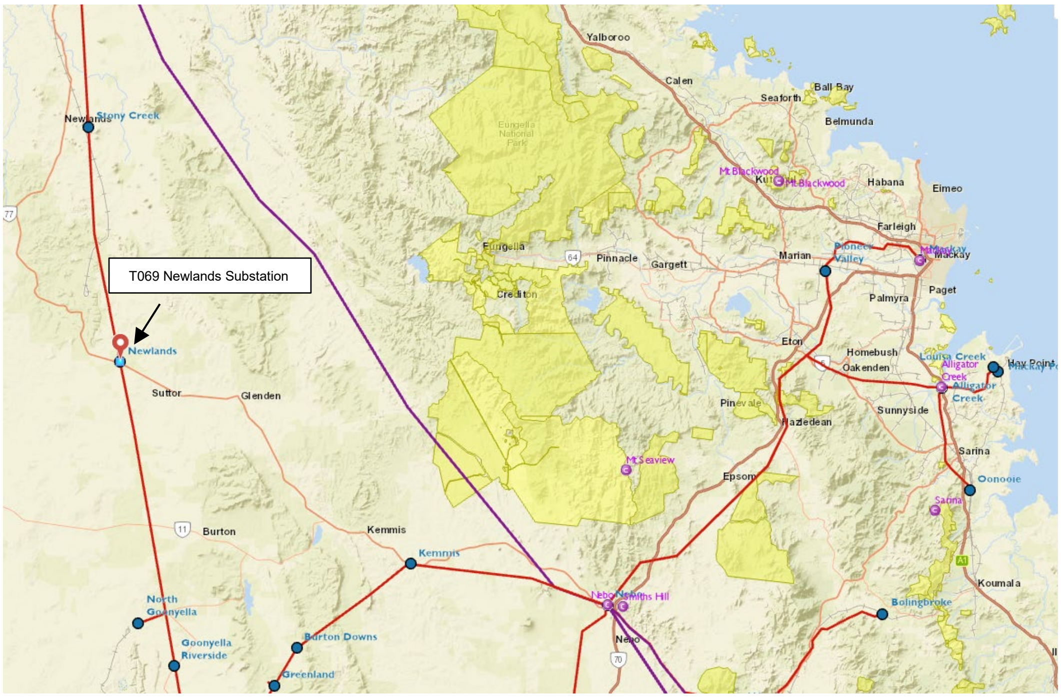


Figure 2: Location of Newlands Substation

3. Deliverables

The following deliverables are to be provided in response to this Project Scope Report. The requirement dates for these deliverables will be communicated separately.

This project will follow the single stage approval process. The following deliverables are required to facilitate full project approval:

1. A report (e.g. Project Proposal) detailing the works to be delivered, proposed staging of delivery, resource requirements and confirmation of availability, and outage requirements

2. A class 3 estimate (minimum), based upon published design advices detailing key design elements, supplier quotation and MSP RFQ

3. A basis of estimate document and risk table, detailing the key estimating assumptions and delivery risks

4. A detailed project staging and outage plan that includes primary plant, secondary systems and telecoms outages

4. Project Scope

4.1. Original Scope

The following scope presents a functional overview of the desired outcomes of the project. The proposed solution presented in the estimate must be developed with reference to the remaining sections of this Project Scope Report, in particular *Section 7 Special Considerations*.

Briefly, the project consists of undertaking life extension works on Transformer 1 at Newlands substation to extend the service life of the transformer by 10 years.

4.1.1. Transmission Line Works

Not applicable

4.1.2. T069 Newlands Substation Works

Undertake the following life extension works for Transformer 1:

- Replace HV, LV, and neutral bushings
- Replace the transformer control cubicle
- Fix the existing oil leaks that do not require lowering the oil in the main tank below the top of the windings. Additionally, all accessible leaking butterfly valves should be either replaced or removed.
- Replace the OLTC PVC breather with a Powerlink approved OLTC breather that has a minimum of 7.5kg of desiccant.
- Address corrosion on OLTC fasteners and linkage. Upgrade the OLTC control cubicle to ensure compliance with AS3000 Standard (for example, install electrical safety barriers to cover the live terminals).

- Clean and seal the oil bund and ensure the oil separation tank is fully functional and has not been impacted by the transformer life extension works.

Decommission and recover all redundant equipment, and update drawing records, SAP records, config files, etc. accordingly.

4.1.3. Telecoms Works

Not applicable

4.1.4. Easement/Land Acquisition & Permits Works

Not applicable

4.2. Key Scope Assumptions

Not applicable

4.3. Variations to Scope (post project approval)

Not applicable

5. Key Asset Risks

The transformer bushings are porcelain and have exceeded their technical service life. Replacement of these bushings is to be prioritised to mitigate the risk of explosive failure.

Asset risk management shall be in accordance with the Asset Risk Management Process Guideline (A4870713).

6. Project Timing

6.1. Project Approval Date

The anticipated date by which the project will be approved is June 2026.

6.2. Site Access Date

Site access is available immediately.

6.3. Commissioning Date

The latest date for the commissioning of the new assets included in this scope and the decommissioning and removal of redundant assets, is June 2028.

7. Special Considerations

The transformer is classified "PCB-free", however, it is recommended to conduct another PCB test before undertaking the life extension works.

8. Asset Management Requirements

Equipment shall be in accordance with Powerlink equipment strategies.

Unless otherwise advised Sarah Gilmour will be the Project Sponsor for this project. The Project Sponsor must be included in any discussions with any other areas of Network and Business Development including Asset Strategies & Planning.

Jay Tencate will provide the primary customer interface with Energy Queensland. The Project Sponsor should be kept informed of any discussions with the customer.

9. Asset Ownership

The works detailed in this project will be Powerlink Queensland assets.

The asset boundary with Energy Queensland is the LV terminals of the 132/66kV transformer.

10. System Operation Issues

Operational issues that should be considered as part of the scope and estimate include:

- interaction of project outage plan with other outage requirements;
- likely impact of project outages upon grid support arrangements; and
- likely impact of project outages upon the optical fibre network.

11. Options

Not applicable

12. Division of Responsibilities

Not applicable

13. Related Projects

Project No.	Project Description	Expected Comm Date	Comment
Co-requisite Projects			
Other Related Projects			
CP.02752	T069 Newlands Primary Plant Replacement	June 2025	
OR.02397	Newlands Selective Equipment Replacement	Jan 2029	

CP.03149 T069 Newlands Transformer 1 Life Extension

Concept Estimate

Table of Contents

1. Executive Summary

Newlands Substation, established in 1983, is a key bulk supply substation fed by two 132kV feeders. It has two transformers: a 40 MVA (T1) and a 100 MVA (T2). Transformer T1, built in 1982 by HYUNDAI, has been in service for 42 years and is beyond its typical 40-year design life.

A 36-year electrical assessment and a follow-up in 2024 found the insulation condition acceptable but identified the need for refurbishment. The goal of the current project is to complete life extension works on T1 to keep it operational for another 10 years.

The objective of this project is to undertake life extension works on Transformer 1 at Newlands substation to extend the service life of the transformer by 10 years by June 2028.

1.1 Project Estimate

		Total ($)
Estimate Class	5	
Estimate accuracy (+% / -%)	100% / -50%	
Base Estimate – Un-Escalated (2025/2026)		2,970,166
TOTAL		**2,970,166**

1.2 Project Financial Year Cash Flows

DTS Cash Flow Table	Un-Escalated Cost ($)
To June 2026	127,938
To June 2027	1,182,089
To June 2028	1,581,746
To June 2029	78,393
TOTAL	**2,970,166**

2. Project and Site-Specific Information

2.1 Project Dependencies & Interactions

This project is related to the following projects:

Project No.	Project Description	Planned Commissioning Date	Comment
Interactions			
CP.02752	T069 Newlands Primary Plant Replacement	2027	
CP.02397	Newlands Selective Equipment Replacement	2029	

2.2 Site Specific Issues

- T069 Newlands Substation is situated within the Newlands region, which is also associated with the Newlands Mine and the Newlands rail system.
- Newlands is a rural locality in the Whitsunday Region, Queensland Australia.
- Newlands is a 132kV/66kV Substation and is a shared site with Energy Queensland's 33kV distribution system. T069 Newlands is an operational substation with Live HV & LV equipment with a control system which is housed in a single level brick building, (shared with Energy Queensland protection and control systems) adjacent to the switchyard.
- Partial discharge maybe present within HV plant at T069 Newlands Substation. To be always monitored when on site.
- Existing public roadway into the substation is hazardous due to the speed limit and entry is near a corner. Traffic control may be required when undertaking works on this site.
- Newlands Substation is 90km from Mackay and is classed as a remote site. Medical assistance available at local hospital, consider telephone reception issues. Consider emergency scenarios and appropriate response.
- Asbestos containing material (ACM) has been identified at T069 Newlands Substation throughout the existing control building. Ensuring the ACM is maintained in a condition that prevents exposure may be compromised if major refurbishment works are undertaken within the building.

- The Collinsville area is subject to the below average number of days of rain. Consideration was given to then when developing the project schedule.

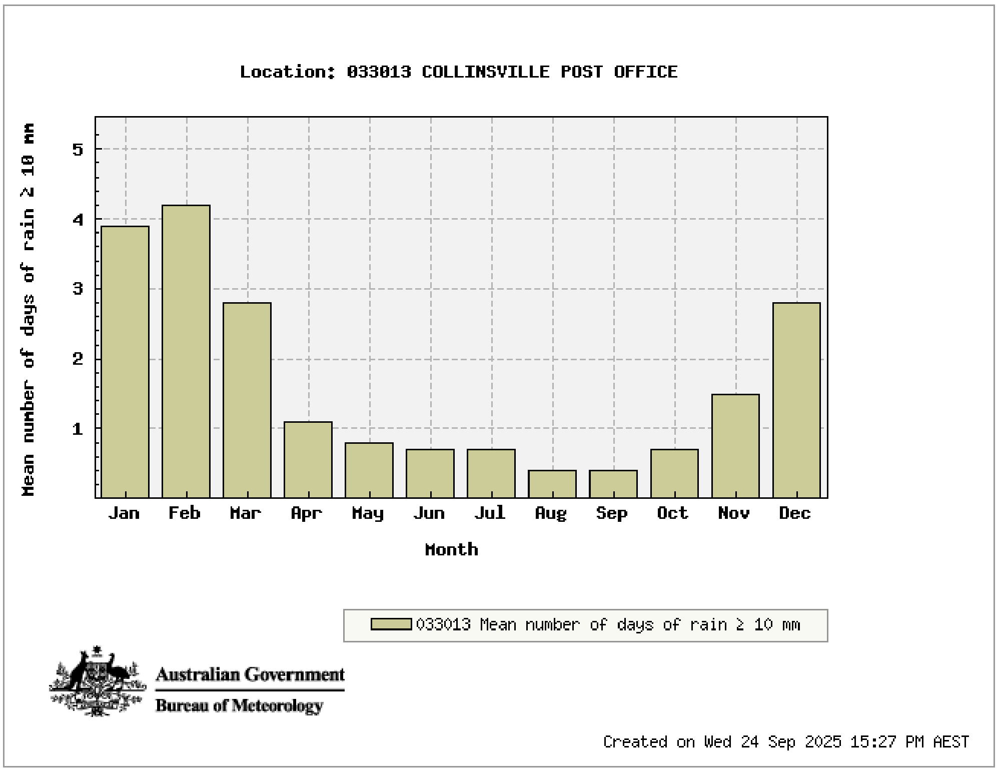


Figure 1 - Number of Days of Rain >10mm Collinsville (Source: Bureau of Meteorology 24th September 2025)

3. Project Scope

The purpose of the current project is to complete life extension works on T1 to keep it operational for another 10 years, with completion targeted date by June 2028.

3.1 Substations Works

T069 Newlands Substation Works:

- Replace High Voltage, Low Voltage, and neutral bushings.
- Replace the transformer control cubicle.
- Fix the existing oil leaks that do not require lowering the oil in the main tank below the top of the windings. Additionally, all accessible leaking butterfly valves should be either replaced or removed.
- Replace the On-Load Tap Changer PVC breather with a Powerlink approved On-Load Tap Changer breather that has a minimum of 7.5kg of desiccant.
- Address corrosion on On-Load Tap Changer fasteners and linkage. Upgrade the On-Load Tap Changer control cubicle to ensure compliance with AS3000 Standard (for example, install electrical safety barriers to cover the live terminals).
- Clean and seal the oil bund and ensure the oil separation tank is fully functional and has not been impacted by the transformer life extension works

Decommission and recover all redundant equipment, and update drawing records, SAP records, config files, etc. accordingly.

3.2 Major Scope Assumptions

The following assumptions were made for this Project Estimate.

- The transformer is classified as PCB-free. It is recommended to conduct another PCB test before undertaking the life extension works.
- Access to network and outage management resources are available.
- All existing equipment in good condition and working order within existing substations.
- No long lead times on procurement items.
- All resources will be available including necessary operational resources are available to complete necessary construction, testing and commissioning activities.
- Availability of site access for works as required.
- Internal design, contractor design and MSP resources are available as required.

3.3 Scope Exclusions

The following items are excluded from the Proposal Estimate.

- Any work outside of normal working hours.
- No allowance for extreme weather events.
- No allowance made for unsuitable material (asbestos and other contamination) including removal, treatment and disposal.
- Any delays, costs or cost increase not within the control of Powerlink.

4. Project Execution

4.1 Project Schedule

A High-Level Project Schedule should be developed and should address the following project stages:

Milestones	High-Level Timing
Request for Class 3 estimate	October 2025
Class 3 Project Proposal Submission	April 2026
Full Project Approval	June 2026
Site Inspection & ITT (Transformer Contractor)	July 2026
Contract Award	September 2026
Procurement (15 Months Lead Time)	September 2026 – October 2027
Site Establishment	June 2027
Construction & Commissioning	June 2028
Project Completion	June 2029

4.2 Network Impacts

Network Impacts at T069 Newlands are increased due to the site's remote location. Any work may result in a temporary loss of power supply to all connected loads, including critical infrastructure and operational systems. Network access is limited, as key parts of the system required for construction activities are only accessible during winter and the shoulder months.

To reduce the risk of disruption, a restoration plan will need to be developed by network operations and supported by the Project team. This will include backup power solutions, clear communication protocols, and a well-defined outage window to support minimal impact and swift restoration of services.

4.3 Resourcing

Design for the project will be completed by internal design resources with support from external design partners. The construction works will be completed by a combination of the Maintenance Service Providers and one of the transformer panel contractors.

5. Project Asset Classification

Asset Class	Base ($)	Base (%)
Substation Primary Plant	2,943,959	99
Substation Secondary Systems	26,207	1
TOTAL	**2,970,166**	**100**

6. References

Document name and hyperlink	Version	Date
Project Scope Report	1.0	7/04/2025

Risk Cost Summary Report

CP.03149

Newlands Transformer 1 Life Extension

Document Control

Change Record

Issue Date	Revision	Prepared by
15/01/2026	1.0	Asset Strategies

Related Documents

Issue Date	Responsible Person	Objective Document Name

Document Purpose

The purpose of this model is to quantify the base case and option risk cost profiles for the Newlands Substation transformer 1 which is proposed for life extension under CP.03149. These risk cost profiles are then included as part of an overall cost-benefit analysis (CBA) to understand the economic benefit of the proposed upgrades. This process provides a benchmarking and internal gate process to support Powerlink in effectively identifying prioritised infrastructure upgrades.

The CBA was designed to demonstrate and quantify the value to be gained through specific infrastructure investments. To evaluate the CBA, an NPV is derived based on the present values of costs and benefits. The flow chart in Figure 4 below designates the methodology used in designing the CBA process.

Key Assumptions

In calculating the risk cost arising from a failure of the ageing equipment at the Newlands Substation, the following modelling assumptions have been made:

- The functionality of the equipment is assumed to decay according to decay curves calculated by Powerlink, and associated probability of failure (PoF).
- Where equipment in scope is replaced, its associated Health Index (HI) score is reverted to one. Where refurbishment is undertaken, the health index is adjusted according to the target life extension.
- The likelihood of personnel within the substation in the event of explosive failure of equipment (used to calculate safety risk) is assumed to be 25% (based upon historic site entry averages), with the likelihood of resulting injury or death depending on the explosive radius of the equipment, its housing, and the total substation land area. The modelling also assumes that personnel are equally likely to be anywhere within the substation land area. No escalation to the likelihood has been made during construction as it is assumed appropriate risk assessments and risk mitigation measures are completed by the project team.
- For the purposes of the cost-benefit analysis, the total useful asset life of 10 years (for this life extension) has been applied (to align with the target life extension).
- A site-specific value of customer reliability (VCR) of $16,720/MWh has been applied when calculating network risks.

Base Case Risk Analysis

Risk Categories

Four main categories of risk are assessed as part of this project as consistent with Powerlink's Asset Risk Management Framework:

- Financial Risk
- Safety Risk
- Network Risk (including market impact if applicable)
- Environmental Risk

Table 1: Risk categories

Risk Category	Failure Types	Equipment in scope
Safety Risk	Explosive failure	All equipment with the potential to fail explosively based on Powerlink's experience
Financial Risk	Peaceful failure	All equipment
	Explosive failure	All equipment with the potential to fail explosively based on Powerlink's experience
Network Risk	Peaceful failure	All equipment related to network elements identified in the planning statement
Environmental Risk	Peaceful failure	None for this project, it is assumed that bunding and oil separation system is 100% effective

Base Case Risk Cost

The modelled and extrapolated total base case risk costs are shown in Figures 1 and 2 below.

Risk costs associated with the equipment in scope are expected to increase from $0.59 million in 2026 to $1.55 million in 2038. Key highlights of the analysis include:

- Financial risks form approximately 92% of the base case risk. Of this, the majority is a result of peaceful failures modes.
- Network risk and safety risk each account for approximately 4% of the total risk, and environmental risk is zero for this project.

Figure 1: Total risk cost

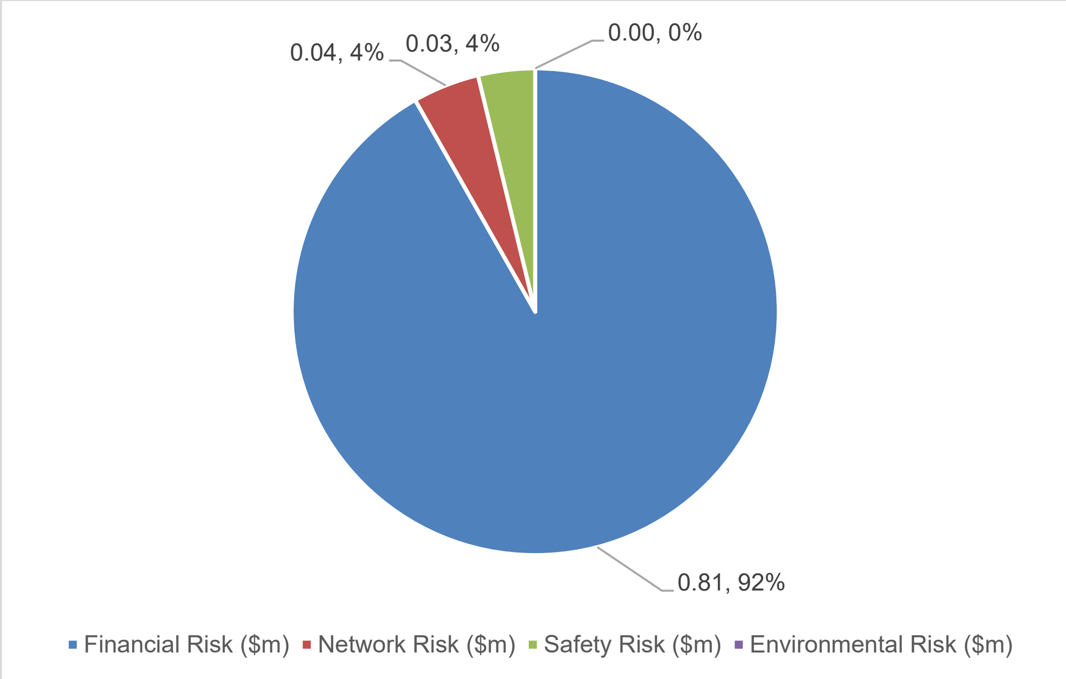


Figure 2: Base case risk cost by contributions (2030)

Option Risk Cost

For modelling purposes, effective HI scores have been reduced to one for equipment replaced under this project (i.e the transformer bushings). For transformer refurbishment activities life extension has been considered in the model by reducing the effective age. Both contribute to a lower probability of failure and therefore lower risk cost.

The figures below set out the total project case risk cost, and associated risk cost savings incremental to the base case.

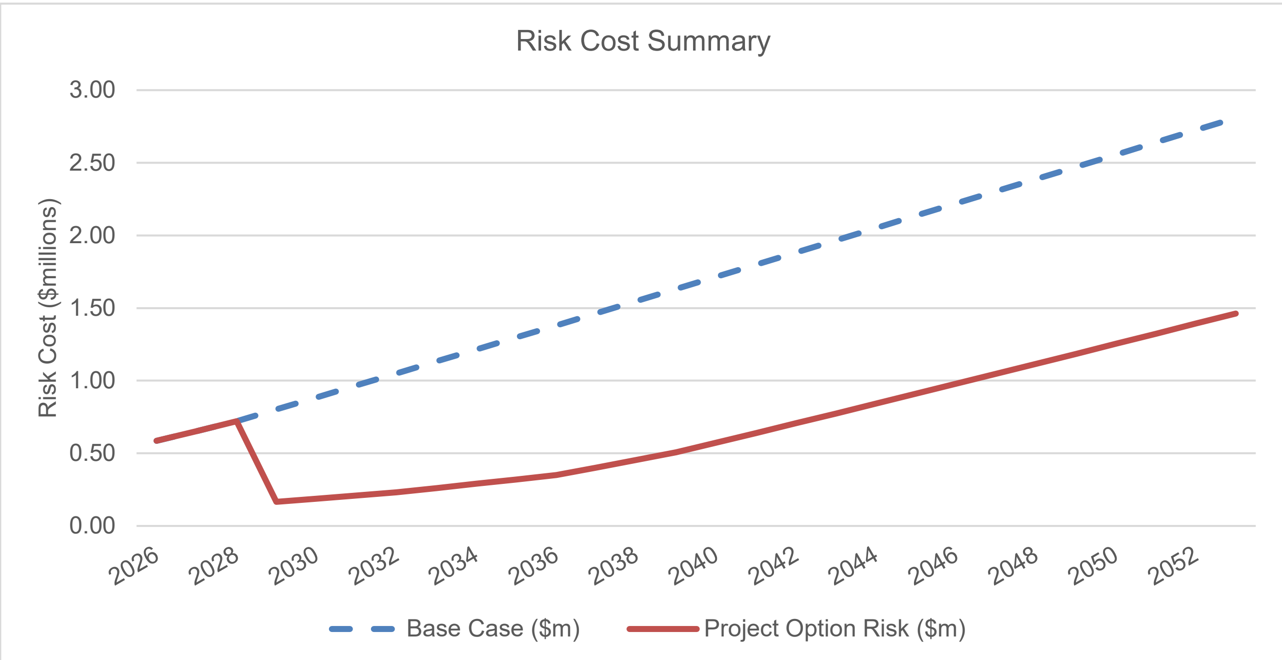


Figure 3: Project Option Risk Cost (compared to base case)

Following the year of investment (2028) the risk cost associated with the equipment in scope effectively reduces to $0.17m. By 2038, the risk cost of the project option is approximately $0.45million, compared with the base case risk cost of $1.55 million.

Cost Benefit Analysis

The methodology designed for the cost benefit is set out as per Figure 4 below.

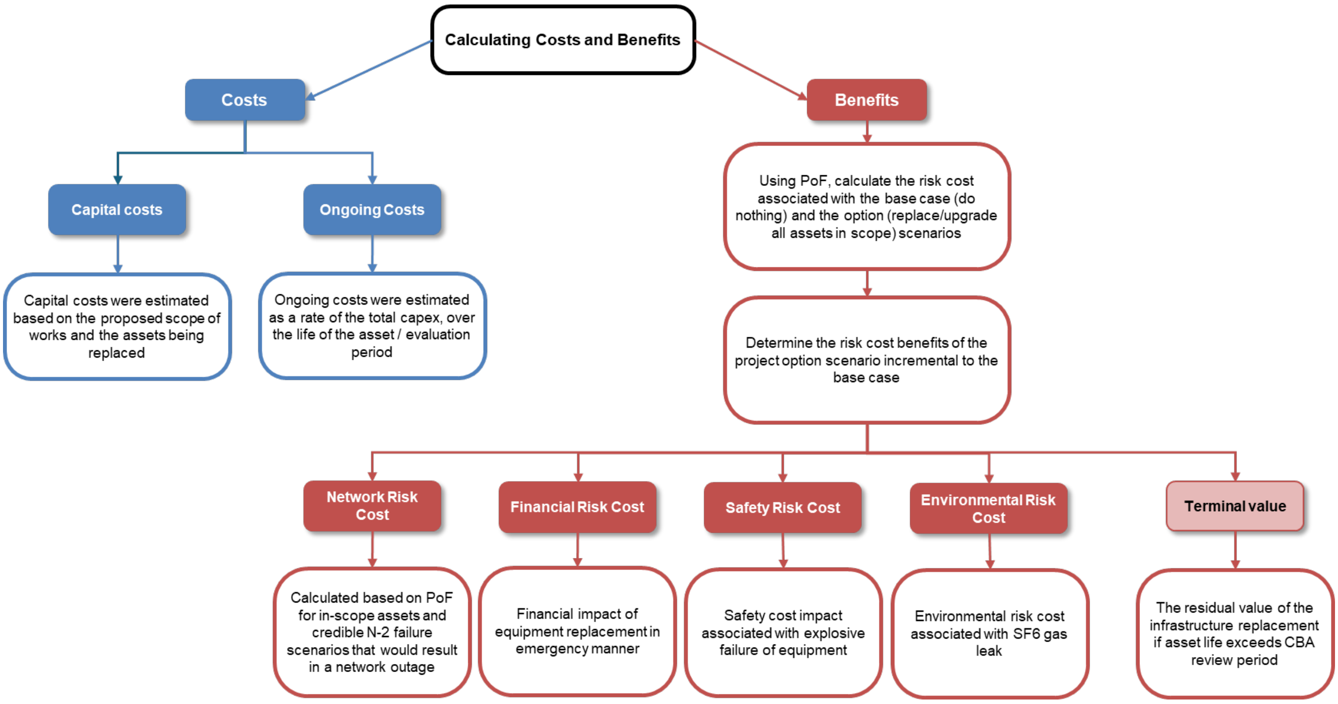


Figure 4: CBA methodology

The project is estimated to cost approximately $2.97 million. This represents a significant cost saving over the estimated financial risk cost of replacing assets individually in an emergency manner, due to the efficiencies associated with planned upgrades.

Based on a baseline discount factor of 7%, the project has a net present value (NPV) of $2.9 million over a 10-year period, and a benefit-cost ratio (BCR) of 2.21.

The project also has a positive NPV and BCR when a discount factor of 10% is applied.

Given this, the scope of work associated with the nominated assets within this project is considered appropriate.

Table 2: Net Present Value and Benefit-Cost Ratio

		Present Value Table ($m)		
Discount rate	%	**3%**	**7%**	**10%**
NPV of Net Gain/Loss	$m	$4.9	$2.9	$2.0
Benefit-Cost Ratio	ratio	2.78	2.21	1.88

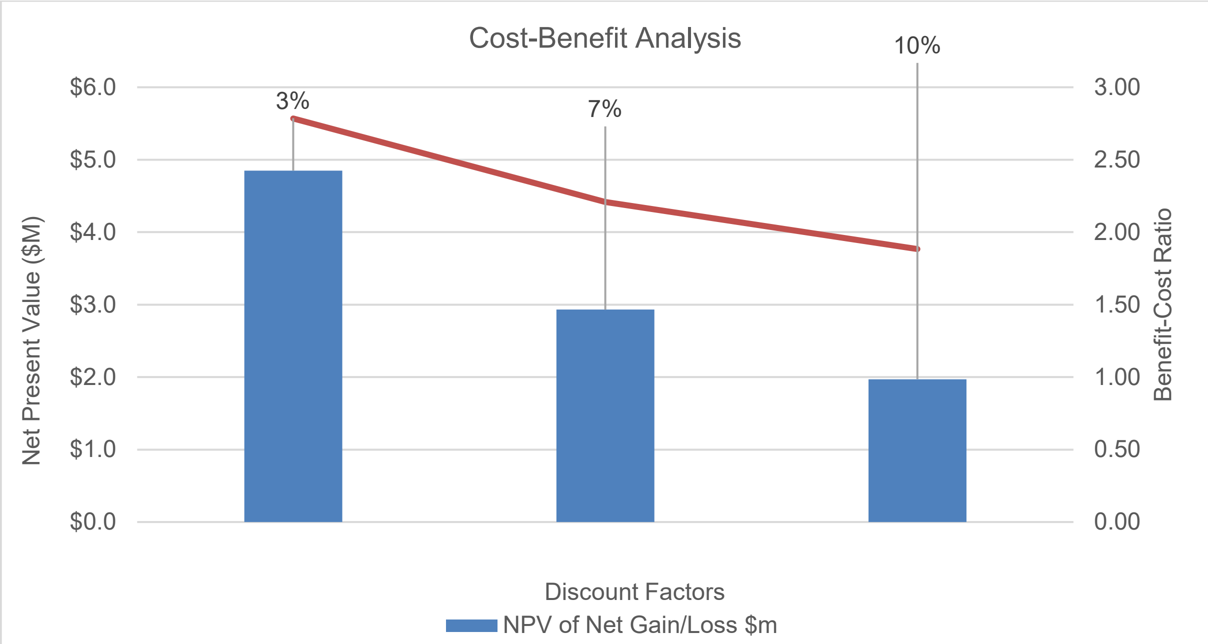


Figure 5: Cost benefit summary

Participation Factors

A sensitivity analysis was undertaken to determine the participation factors for key inputs to the risk cost models (i.e. to identify which inputs are most sensitive to overall risk cost). Applying a 50% reduction in key inputs still resulted in a cost benefit ratio equal to 2.06.

The participation factor is defined as the ratio of percentage change in output (i.e. risk cost) to a percentage change in input (e.g. VCR). The participation factors for key model inputs are shown in the table below.

Due to the non-linear nature of the risk cost model (especially network risk costs, which are a function of concurrent failures), the participation factor can change depending on the magnitude of input percentage change.

The model is most sensitive to:

- **changes in emergency premium (peaceful failure)** results in a decrease in risk cost of $0.05 million, or approximately 7.26% of the original base risk.

Table 3: Participation Factors

Input	Baseline value	Sensitivity value (-50%)	Change in risk cost at 2030 ($m)	CBA	Participation (%)
Safety					
Likelihood of personnel within substation	25%	12.5%	-0.01	2.15	-1.83%
Cost consequence of multiple fatality	$11,400,000	$5,700,000	0.00	2.19	-0.57%
Cost consequence of single fatality	$5,700,000	$2,850,000	0.00	2.22	0.27%

Cost consequence of multiple serious injury	$4,206,600	$2,103,300	0.00	2.20	-0.40%
Financial					
Emergency premium (peaceful failure)	20%	10%	-0.05	2.06	-7.26%
Emergency premium (explosive failure)	100% (Pwr TX) 30% (Bushings)	50% (Pwr TX) 15% (Bushings)	-0.01	2.18	-0.89%
Network					
VCR ($/MWh)	16,720	8,360	-0.02	2.15	-2.36%
Restoration Time (hrs)	168-720	84-360	-0.01	2.18	-1.34%