2023-27
POWERLINK QUEENSLAND REVENUE PROPOSAL

Project Pack – PUBLIC

CP.xxxxx
Calvale Selective Primary Plant Replacement

CP.0XXXX – Calvale Selective Primary Plant Replacement

Project Status: Not Approved

1. Network Need

H024 Calvale Substation, approx. 150km south of Rockhampton, was established in the mid-1980s and is a bulk supply point for Moura and Biloela substations. It provides essential power transfer capabilities between Central West Queensland and Gladstone and Southwest Queensland loads, and is the point of connection for Callide generators. An outage at Calvale Substation would leave up to 110MW and up to 2,100MWh of customer load per day at risk[2].

A Condition Assessment (CA) conducted in February 2020 identified selective primary plant at Calvale Substation will reach its end of technical service life by June 2025[1]. Selective primary plant bays at Calvale Substation have circuit breakers (CBs), current transformers (CTs), and capacitor voltage transformers (CVTs) (including structures) which are approaching their end of life or are obsolete with no spare parts, and in some instances susceptible to explosive failure.

Energy Queensland forecasts confirm an enduring need to energy supply loads at Biloela and Moura. The removal or failure primary plant at Calvale Substation would violate Powerlink's Transmission Authority reliability obligations (N-1-50MW / maximum 600MWh unserved energy).

Further decline in Calvale primary plant asset condition increases the risk of failure that may cause network outages, safety incidents and additional network costs to replace assets under emergency conditions. The CA recommends replacement of the asset prior to 2025 to manage these risks and ensure network reliability. Failure to address the existing condition of this asset is likely to result in non-compliance with Powerlink's reliability and safety obligations[6].

2. Recommended Option

As this project is currently 'Not Approved', project need and options will be subjected to the public Regulatory Investment Test for Transmission (RIT-T) consultation process to identify the preferred option closer to the time of investment.

The current recommended option is to replace selective primary plant at Calvale Substation by 2025[2].

The following options have been identified to address the condition issues of the transformers:

- Do Nothing – rejected due to non-compliance with reliability standards and safety obligations.
- Provide supply from Blackwater Substation – rejected due to additional cost and interference with local renewable generation to reinforce the 132kV from Blackwater to support existing loads.
- Non Network Option parameters outlined – at this stage no viable option has been identified.

Figure 2-1 below shows the current recommended option reduces the forecast risk monetisation profile of Calvale Substation selective primary plant to approx. $1m per annum in 2026. The residual risk is not reduced to $0 p.a. due to the selective nature of the replacement works. The recommended option will extend the asset life by approx. 20 years.

Where a 'Do Nothing' scenario is adopted, the forecast level of risk associated with the asset escalates to ~$20m per annum in 2030. This is predominantly due to safety risks (injury to personnel on site) for explosive failures (e.g. of CTs, CVTs) or uncleared faults.[3]

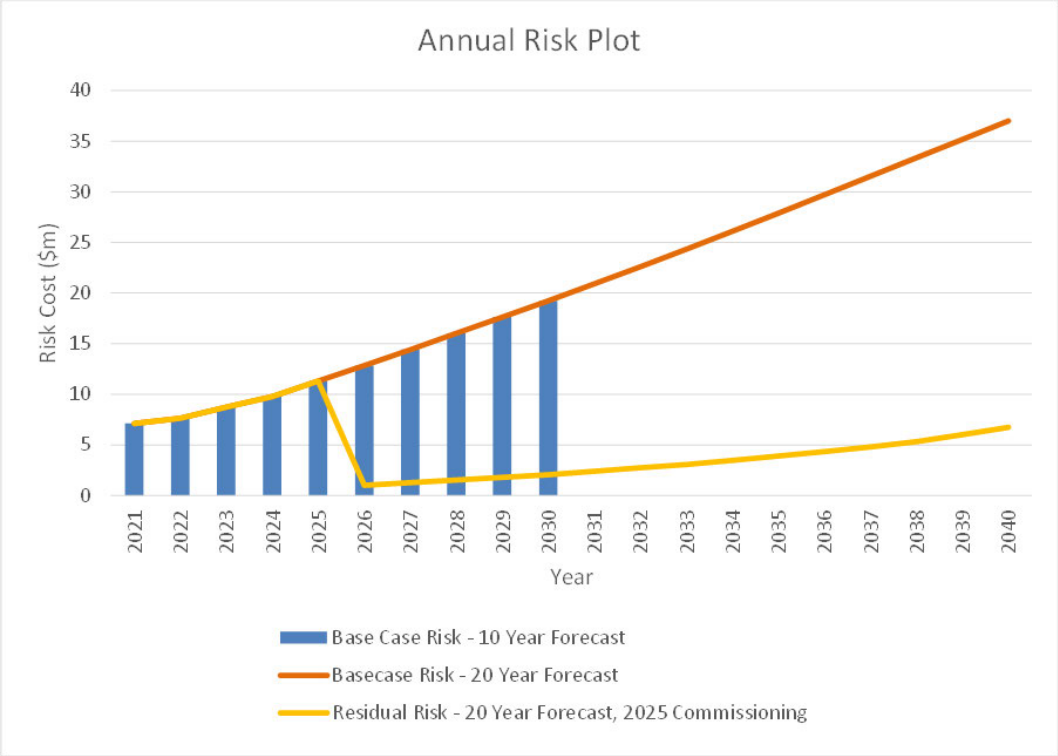


Figure 2-1 Annual Risk Monetisation Profile (Nominal)

3. Cost and Timing

The estimated cost to replace selective CTs, CBs and CVTs at Calvale Substation is $12.7m ($2019/20 Base).

Target Commissioning Date: June 2026[5]

Note: The target commissioning date has been extended to accommodate project staging and to align outage requirements with the customer's scheduled generator maintenance outages.

4. Documents in CP. 0XXXX Project Pack

Public Documents

1. Site Condition Assessment Report H024 Calvale
2. CP.xxxxx – H024 Calvale Substation Selective Replacement of Primary Plant - Planning Statement
3. Base Case Risk and Maintenance Costs Summary Report H024 Calvale Substation Selective Replacement of Primary Plant
4. Project Scope Report CP.xxxxx H024 Calvale Substation Selective Replacement of Primary Plant
5. Concept Estimate for CP.xxxxx - H024 Calvale Substation Selective Replacement of Primary Plant

Supporting Documents

6. Asset Reinvestment Criteria - Framework
7. Asset Management Plan 2021

SITE CONDITION ASSESSMENT REPORT

H024 CALVALE

Asset Category:	Substation Primary	Author:	[redacted]	Authorisation:	[redacted]
Reviewed by:	[redacted]		Review Date:	17/02/2020	
Activity:	Condition assessment -275/132 kV primary substation plant and site infrastructure, incl. civil components – SITE BASED				
Document Type:	Report	Team:	Substation team		
Authorisation date:		Date of site visit:	8&9/1/2020		

Date	Version	Objective ID	Nature of Change	Author	Authorisation
24/02/2020	1	A3320203	Original Issue	[redacted]	[redacted]

Note: *Where 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: - The condition assessment report provides an overview of the condition of all structures and equipment (excluding protection relays, control systems and telecommunication equipment)as stated in the scope and high level recommendations for their timely replacement. As it is snapshot in time and subject to the accuracy of prediction methodology, it is valid for 3 years form site visit date or issue date (whichever is later) stated above.

CONTENTS

EXECUTIVE SUMMARY

This report provides an overview assessment of the condition of the Powerlink owned primary plant at H024 Calvale Substation, as per defined scope below. The report is intended to assist with determining the future strategies for refurbishment and replacement of primary substation plant. The report may contain some recommendations/suggestions related to condition based maintenance activities.

The assessment has been formulated based on the data extracted from the computerised maintenance management system (SAP) including:

- notifications and work orders, dissolved gas analysis (DGA) and other test and measurement results,
- equipment age information combined with available photos,
- historical data analysis,
- information available in the previous condition assessment report, and
- site inspection and civil condition assessment report dated 31/01/2020 (Objective Id.A3296102).

The summary of recommendations is contained in Table 21 presented in Section 3 of this report.

1. INTRODUCTION

This condition assessment is based on a site visit conducted on 8th to 9th January 2020, information provided in civil engineering condition assessment report dated 31st January 2020, available design data and drawings, SAP data and information provided by the maintenance service providers.

1.1 System information

H024 Calvale Substation was established in the mid-1980s. It is located in Central Queensland area and has 275/132kV operating voltages in one yard.

The 275/132kV systems at Calvale substation were originally built in 1988 to connect 2 x generator units at H30 Callide B Power Station, Wurdong feeder 871 and T022 Callide A feeder 7161 (Bay =C03 and =C05).

- The substation was extended in 1998 to connect H050 Callide C Power Station and Tarong substation (Bay =C06 and =C07) including 2 x feeder reactor bays.
- Thermal constraints with the Central Queensland area led to two new bays, =C01 and =C02, being established in 2013 as part of the reinforcement works between Calvale and Stanwell.

As a result of substation extensions with load growth and system augmentation, a mixture of HV primary plant is currently established at Calvale, ranging in age from 1988 through to 2013.

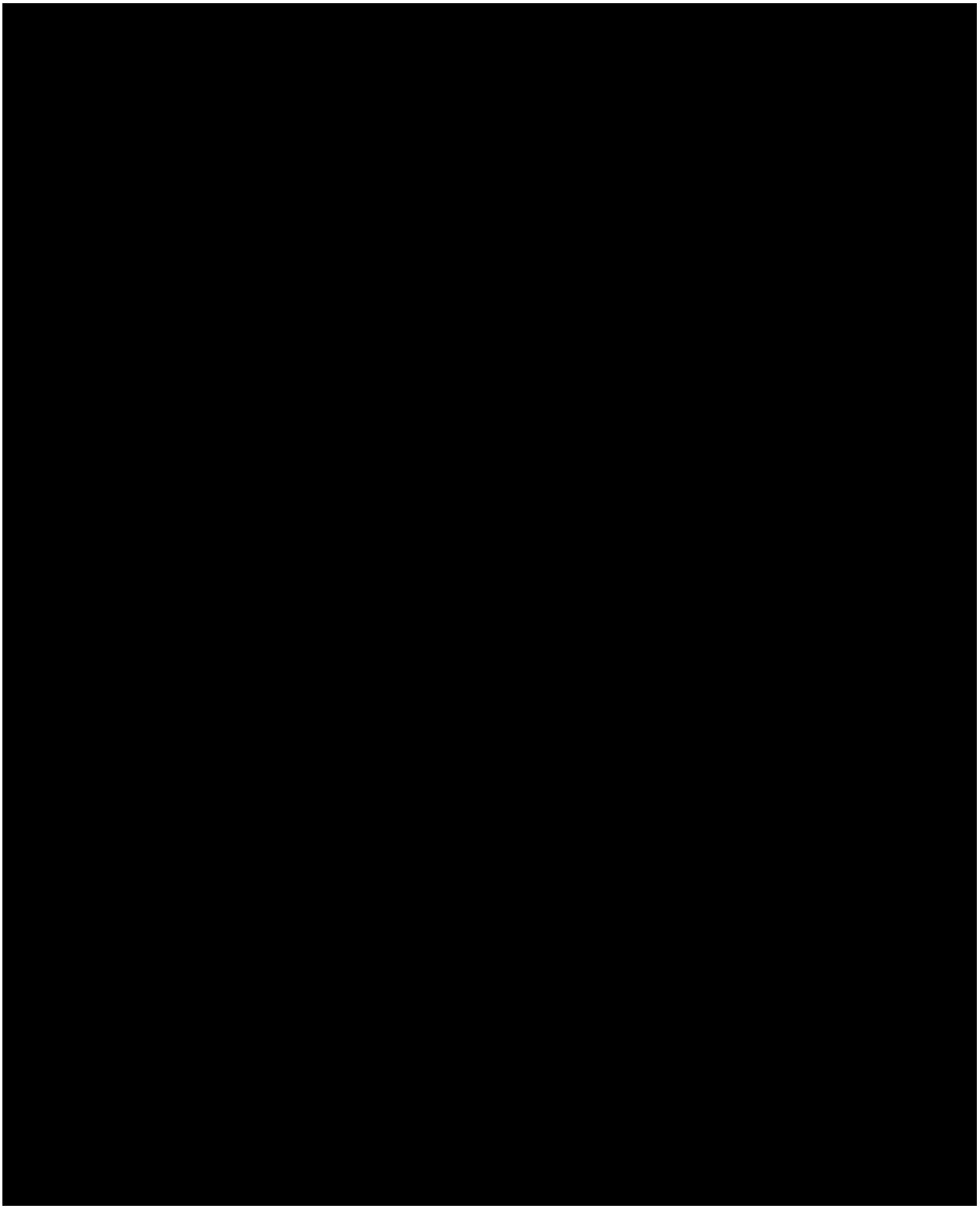


Figure 1 Single Line Diagram

Figure 2: Aerial Photograph of H024 Calvale Substation –2015

Figure 3: H024 Calvale General Arrangement

Figure 4: Location of Substation from PQ Maps

1.2 Asset Age

The original assets were installed in 1988. Subsequent development on site during the period 1988 to 2013 includes the addition of 275kV and 132kV feeder bays.

Additions or replacements in the last 20 years include.

- CP. 01151 Calvale & Callide B Secondary System Replacement
- CP. 01060 Calvale 275kV Transformer (System Spare)
- CU.00022 Calvale JR1 Upgrade – CS Energy
- CP.02152 Calvale Stage 2 Sec Sys Replacement (NR)
- CP.00856 Calvale Transformer Replacement
- OR.00926 Calvale – Tarong BS 1034 Access Track Refurbishment
- CP.00655 Calvale/Tarong Transm Reinforcement
- CP.01546 Callide A - Calvale 132kV Network Reinvest
- CP.01705 Calvale - Stanwell 275kV DCST Line
- OR.01759 ABB Twin Leg CT Replacement - H024 Calvale

Apart from the above additions and replacements, all other originally installed equipment is still in service. The service period being 34 years.

1.3 Ratings

Fault levels calculated in February 2019 are:

- 275 kV – 23.46 kA
- 132 kV – 8.75 kA
- 19.1 kV – 10.20 kA

All equipment at this site is rated adequately for these calculated fault levels.

Functional Loc.	Description	Start-up date	Bay Continuous Rating	Bay Fault Current Rating	Fault Current Period	Comments on Rating
H024-C01-501-	275KV 1 COUPLER BAY	10/05/2013	2500A	40KA	1.0s	Sufficient
H024-C01-855-	855 FEEDER BAY	10/05/2013	2500A	40KA	1.0s	Sufficient for feeder
H024-C01-BLF-	275KV BLANK FEEDER BAY	19/09/2013	-	-	-	
H024-C02-502-	275KV 2 COUPLER BAY	10/05/2013	2500A	40KA	1.0s	Sufficient
H024-C02-8873-	8873 FEEDER BAY	10/05/2013	2500A	40KA	1.0s	Sufficient for feeder
H024-C02-BLF-	BLANK FEEDER BAY	19/09/2013	-	-	-	
H024-C03-503-	275KV 3 COUPLER BAY	01/07/1987	2500A	31.5kA	1.0s	Sufficient
H024-C03-541-	275kV 1 TRANSF BAY	01/07/1984	2500A	31.5kA	1.0s	Limited to 1600A by CT's Recommend changing CT ratio to 1200/1
H024-C03-8874-	8874 FEEDER BAY	25/10/2013	2500A	31.5kA	1.0s	Limited to 1600A by T1 CT's Recommend changing CT ratio to 1200/1
H024-C04-504-	275KV 4 COUPLER BAY	01/07/1987	2500A	31.5kA	1.0s	Sufficient
H024-C04-542-	275KV 2 TRANSF BAY	01/07/1987	1275A	31.5kA	1.0s	
H024-C04-851-	851 FEEDER BAY	01/07/1987	1000A	31.5kA	1.0s	Sufficient for 375MVA gen
H024-C05-505-	275KV 5 COUPLER BAY	01/07/1987	2500A	31.5kA	1.0s	Sufficient
H024-C05-852-	852 FEEDER BAY	01/07/1987	1000A	31.5kA	1.0s	Sufficient for 375MVA gen
H024-C05-871-	871 FEEDER BAY	01/07/1987	2500A	31.5kA	1.0s	Limited to 1600A by 852 CT's Sufficient for all but Shoulder & Winter Short term
H024-C06-506-	275KV 6 COUPLER BAY	01/07/1998	2500A	31.5kA	1.0s	Sufficient
H024-C06-853-	853 FEEDER BAY	28/02/2000	2500A	31.5kA	1.0s	Sufficient for 562MVA gen
H024-C06-8810-	8810 FEEDER BAY	01/07/1998	2500A	31.5kA	1.0s	Limited to 2000A by CT ratio Recommend changing CT ratio to 1600/1

Functional Loc.	Description	Start-up date	Bay Continuous Rating	Bay Fault Current Rating	Fault Current Period	Comments on Rating
H024-C07-507-	275KV 7 COUPLER BAY	01/07/1998	2500A	31.5kA	1.0s	Sufficient
H024-C07-854-	854 FEEDER BAY	05/03/2000	2500A	31.5kA	1.0s	Sufficient for 560MVA gen
H024-C07-8811-	8811 FEEDER BAY	01/07/1998	2500A	31.5kA	1.0s	Limited to 2000A by CT ratio Recommend changing CT ratio to 1600/1
H024-D01-441-	132kV 1 TRANSF BAY	29/03/2019	-	-	-	Yet to be commissioned
H024-D02-7159	7159 FEEDER BAY	12/04/2019	-	-	-	Yet to be commissioned
H024-D03-7109	7109 FEEDER BAY	06/06/2019	-	-	-	Yet to be commissioned
H024-D04-442-	132kV 2 TRANSF BAY	01/07/1987	2500 A	31.5kA	1.0s	
H024-D04-7161	7161 FEEDER BAY	01/07/1987	1275 A	31.5kA	1.0s	Limits feeder but not T2 so OK rating for current config
H024-E03-1311	33kV UNDERGROUND CABLE BS 1311	01/07/1987	345A	10kA	1.0s	
H024-E03-253-	19kV 3 STN TRANSFORMER BAY	01/07/1984	-	-	-	
H024-KC1-1BU5	275kV 1 BUS	05/07/1999	3490 A			Sufficient
H024-KC2-2BU5	275kV 2 BUS	05/07/1999	3490 A			Sufficient
H024-KD3-3BU4	132kV 3 BUS	29/03/2019				SAP Data defect
H024-M01-1REA	1 REACTOR	19/11/1998				
H024-M02-2REA	2 REACTOR	19/11/1998				
H024-T01-1TRF	1 TRANSFORMER	29/03/2019				
H024-T02-2TRF	2 TRANSFORMER					

Table 1

The standard bay continuous ratings for a 275kV bays is 2500A and 132kV bay is 1600A, there are a number of circuits that are limited by the feeder or transformer rating, and planning is to confirm whether there is an enduring need to upgrade these ratings to current standards.

Although some equipment at this site is also not rated for fault currents in accordance to the current Powerlink standard, all equipment at this site is rated adequately for the calculated fault levels at present and for the next 10 years.

1.4 Scope of condition assessment report

The site condition assessment is restricted to Powerlink owned high voltage equipment and associated support structure and site infrastructure at H024 Calvale substation with the **exclusion** of:

- Power Transformer No.1
- Power Transformer No.2
- 275kV Line Reactor No.1
- 275kV Line Reactor No.2
- 132kV feeder bays D1, D2,D3 & D4 7161 (constructed in 2019 under CP.01546)
- 275kV Diameter C01 & C02 (constructed in 2013 under CP.01705)
- Protection and control systems which are subject to a separate condition assessment report.

2. CONDITION ASSESSMENT

2.1 Buildings

2.1.1 Building layout and usage

There is one control building and a shed on this site. The original control building is brick construction with a steel metal roof and was commissioned in 1987. This building houses Powerlink 275/132kV control panels, the 125V and 50V DC supply systems and telecommunication equipment. It consists of a control/relay room, communications room, battery room, amenities room and toilet. The control, battery and comms rooms are all air conditioned. The majority of windows have bars installed. The building is reasonably well maintained and no significant issues were noticed. shown in Figure 5.

Figure 5: Control Room Building

Asbestos is not present in the control building, however it was found in various objects around the yard. Asbestos may be present in other areas that were not accessed while compilling the register.

A storage shed is located in vicinity of the control building. The shed exterior is in good condition and no issues were noted. See Figure 6.

Figure 6: Storage Shed

Figure 7: Water Tanks at wash-down station

There are no permanent water tanks within the yard. Two water tanks are positioned outside the yard at the wash-down station. The tanks are made from polyethylene and are in good condition. See Figure 7

Recommendation: Based on the condition it is recommended that this brick building is fit for purpose for another 40 years with regular maintenance.

2.2 Primary Plant Bays

2.2.1 H024-C03-503- 275kV 3 COUPLER BAY

The equipment for this bay is listed in the Table 2, including a health index value for each item.

The original equipment comprising circuit breaker, isolators and current transformers were installed in early to mid-1988.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-C03-503--5030-1	EARTH SWITCH	MERLIN GERIN	DR	01.07.1977	5
H024-C03-503--5030-2	EARTH SWITCH	MERLIN GERIN	DR	01.07.1977	5
H024-C03-503--5023	CIRCUIT BREAKER	MITSUBISHI	250-SFM-40B	02.08.1988	7
H024-C03-503--5032CTA	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1987	7
H024-C03-503--5032CTA	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1987	7
H024-C03-503--5032CTA	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1987	7
H024-C03-503--5038	ISOLATOR	EGIC	DR	01.07.1988	4
H024-C03-503--5039	ISOLATOR	EGIC	DR	01.07.1988	4

Table 2

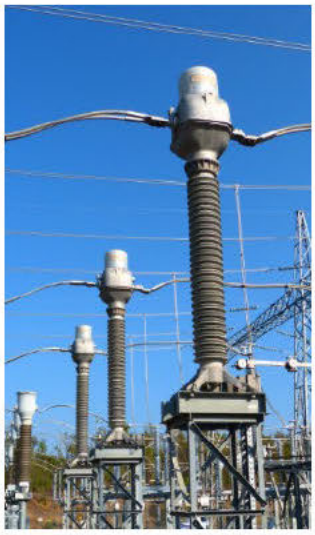


Figure 8: CT's

Figure 9: CB Mech box

The circuit breaker in this bay is a Mitsubishi 250–SFM-340B manufactured in 1987 and installed in 1988. It has pneumatic operating mechanism with air and spring used for energy storage and SF6 gas for insulating medium. SFM type Mitsubishi CBs of this vintage have asbestos impregnated washers of friable nature associated with the heater inside the mechanism box. Mitsubishi does not produce this type of circuit breaker anymore and sourcing of spare parts has become a major issue. Wiring inside the mechanism box is cracked due to UV penetrating through viewing window.

Maintenance records show that this CB had issues with unloader valve and pressure relief valve of the air compressor system. This CB has been in service for 33 years and it is estimated that it has a remaining service life of 5 years.

The Haefely oil filled current transformers are in satisfactory condition considering they have been in service for 33 years, and the DGA/moisture in oil analysis is satisfactory. There are no identified issues with oil seal integrity. Current transformers with paper and oil insulation within a porcelain housing have been found to have an increased probability of explosive failure after 36 years in service, with potentially catastrophic safety consequences. Considering their age and construction, it is recommended to replace these in 5 years.

The two isolators, 5038 and 5039 installed in this bay are in good condition and maintenance records show no associated problems.

The associated structures and foundations in this bay have a remaining service life of 20 years.

Recommendation: Based on the above observations, it is recommended that CB and CT incl. structures and foundations are replaced within the next 5 years preferably using dead tank CB.The rest of the HV plant is in good condition and no replacements are required in the next 10 year outlook.

It is recommended to continue monitoring condition of structures and foundations in this bay for another 10-15 years (if not replaced with the equipment) and plan their replacement in 20-30 years.

2.2.2 H024-C03-541- 275kV 1 TRANSFORMER BAY

The equipment for this bay is listed in the Table 3, including a health index value for each item.

The original equipment comprising of a circuit breaker, isolators, voltage transformer and current transformers were installed in 1987. The surge arrestors were replaced in 2019.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-C03-541--1TRFSAA	SURGE ARRESTOR (GAPLESS)	ABB		29.03.2019	1
H024-C03-541--1TRFSAB	SURGE ARRESTOR (GAPLESS)	ABB		29.03.2019	1
H024-C03-541--1TRFSAC	SURGE ARRESTOR (GAPLESS)	ABB		29.03.2019	1
H024-C03-541--5410	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	6
H024-C03-541--5410-1	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	6
H024-C03-541--5410-2	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	6
H024-C03-541--5410-3	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	6
H024-C03-541--5411	ISOLATOR	EGIC	DR	01.07.1988	5
H024-C03-541--5412	CIRCUIT BREAKER	MITSUBISHI	250-SFM-40B	02.08.1988	7
H024-C03-541--5412CTA	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	16.02.1996	4
H024-C03-541--5412CTB	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1987	7
H024-C03-541--5412CTC	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1987	7
H024-C03-541--5413	ISOLATOR	EGIC	DR	01.07.1988	5
H024-C03-541--5417	ISOLATOR	EGIC	DR	01.07.1988	5
H024-C03-541--7VTB	CAPACITOR VOLTAGE TRANSFORMER	HAEFELY	CVE300/1050	01.07.1984	6

Table 3

The circuit breaker in this bay is a Mitsubishi 250–SFM-340B installed in 1988. It has a pneumatic operating mechanism with air and spring used for energy storage and SF6 gas for insulating medium. SFM type Mitsubishi CBs of this vintage have asbestos impregnated washers of friable nature associated with

the heater inside the mechanism box. Mitsubishi does not produce this type of circuit breaker anymore and sourcing of spare parts has become a major issue. Wiring inside the mechanism box is cracked due to UV penetrating through viewing window.

Maintenance records show minor issues with wiring inside the mechanism box is cracked due to UV penetrating through viewing window and shielding installed on the cables to prevent UV damage. This CB has been in service for 33 years and it is estimated that it has a remaining service life of 5 years.

Figure 10: CB

Figure 11: CVT

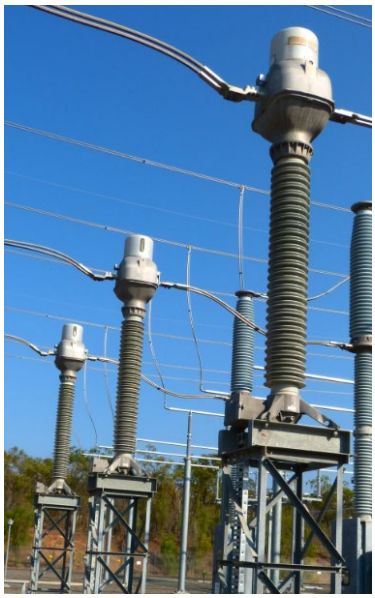


Figure 12: CT's

The A phase CT was replaced in 1997 and appears to be in an acceptable condition. The remaining oil filled instrument transformers are in reasonable condition considering they have been in service for 33 years, and the DGA/moisture in oil analysis is satisfactory. There are no identified issues with oil seal integrity. However, considering their age and construction, it is recommended to replace all CTs and the CVT in 5 years to manage potential safety risks.

The EGIC isolators installed in this bay are in good condition and maintenance records show no problems associated with these.

The associated structures and foundations in this bay have a remaining service life of 20 years.

Recommendation: Based on the above observations, it is recommended that CB , CT and CVT including structures and foundations are replaced within the next 5 years, preferably using a dead tank CB.The rest of the HV plant is in good condition and no replacements are required in the next 10 year outlook.

It is recommended to continue monitoring condition of structures and foundations in this bay for another 10-15 years (if not replaced with the equipment) and plan their replacement in 20-30 years.

2.2.3 H024-C03-8874- 8874 FEEDER BAY

The equipment for this bay is listed in the Table 4, including health index value for each item. This bay was built in 1988, with some of original equipment replaced in various years.

The circuit breaker in this bay is a Mitsubishi 250–SFM-340B manufactured in 1987 and installed in 1988. It has pneumatic operating mechanism with spring used for energy storage and SF6 gas for insulating medium. SFM type Mitsubishi CBs of this vintage have asbestos impregnated washers of friable nature associated with the heater inside the mechanism box. Mitsubishi does not produce this type of circuit breaker anymore and sourcing of spare parts has become a major issue. Wiring inside the mechanism box is cracked due to UV penetrating through viewing window.

Maintnance records show that this CB had issues with pressure relief valve of the air compressor system.This CB has been in service for 33 years and it is estimated that this CB has a remaining service life of 5 years.

The Haefely oil filled current transformers are in satisfactory condition considering they have been in service for 33 years, and the DGA/moisture in oil analysis is satisfactory. There are no identified issues with oil seal integrity. However, considering their age and construction, it is recommended to replace all CTs in 5 years to manage potential safety risks.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-C03-8874-6VTA	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TEMP287C	11.02.2010	3
H024-C03-8874-6VTB	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TEMP287C	11.02.2010	3
H024-C03-8874-6VTC	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TEMP287C	11.02.2010	3
H024-C03-8874-88740	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C03-8874-88740-1	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C03-8874-88740-2	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C03-8874-88740-3	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C03-8874-88741	ISOLATOR	EGIC	DR	01.07.1988	4
H024-C03-8874-88742	CIRCUIT BREAKER (SF6 SPRING MultiVol)	MITSUBISHI	250-SFM-40B	02.08.1988	7
H024-C02-8873-88733	ISOLATOR	EGIC	DR	01.07.1988	4
H024-C02-8873-88737	ISOLATOR	EGIC	DR	01.07.1988	4
H024-C03-8874-8874CTA	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1987	7
H024-C03-8874-8874CTB	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1987	7
H024-C03-8874-8874CTC	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1987	7
H024-C03-8874-874SAA	SURGE ARRESTOR (GAPLESS)	SIEMENS	3EL2 240-2PM32-4KA1	25.10.2013	1
H024-C03-8874-8874SAB	SURGE ARRESTOR (GAPLESS)	SIEMENS	3EL2 240-2PM32-4KA1	25.10.2013	1
H024-C03-8874-8874SAC	SURGE ARRESTOR (GAPLESS)	SIEMENS	3EL2 240-2PM32-4KA1	25.10.2013	1

Table 4

The associated structures and foundations are in good condition and are expected to have a remaining life of 20 years.

Recommendation: Based on the above observations, it is recommended that CB and CT incl. structures and foundations are replaced within the next 5 years preferably using a dead tank CB.The rest of the HV plant is in good condition and no replacements are required in the next 10 year outlook.

It is recommended to continue monitoring condition of structures and foundations in this bay for another 10-15 years (if not replaced with the equipment) and plan their replacement in 20-30 years.

2.2.4 H024-C04-504- 4 COUPLER BAY

The equipment in this bay is listed in Table 5, including health index value for each item. The original equipment comprising circuit breaker, isolators and current transformers was installed in early to mid-1989.

Similar to the other Mitsubishi 250–SFM-340B circuit breakers in this substation, there are a number of issues identified in the maintenance records. This CB has issues with SF6 gas leaks and was topped up with SF6 gas every year since 2006. This CB has been in service for 33 years and it is estimated that it has a remaining service life of 5 years.

The Haefely oil filled current transformers are in satisfactory condition considering they have been in service for 33 years, and the DGA/moisture in oil analysis is satisfactory. There are no identified issues

with oil seal integrity. However, considering their age and construction, it is recommended to replace all CTs in 5 years to manage potential safety risks.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-C04-504--5040-1	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C04-504--5040-2	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C04-504--5042	CIRCUIT BREAKER	MITSUBISHI	250-SFM-40B	02.08.1988	7
H024-C04-504--5042CTA	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1987	7
H024-C04-504--5042CTB	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1986	7
H024-C04-504--5042CTC	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1987	7
H024-C04-504--5048	ISOLATOR	EGIC	DR	01.07.1988	4
H024-C04-504--5049	ISOLATOR	EGIC	DR	01.07.1988	4

Table 5

The associated structures and foundations are in good condition and are expected to have a remaining life of 20 years.

Recommendation: Based on the above observations, it is recommended that CB and CT including structures and foundations are replaced within the next 5 years preferably using a dead tank CB.The rest of the HV plant is in good condition and no replacements are required in the next 10 year outlook.

It is recommended to continue monitoring condition of structures and foundations in this bay for another 10-15 years (if not replaced with the equipment) and plan their replacement in 20-30 years.

2.2.5 H024-C04-542- 275kV 2 TRANSFORMER BAY

The equipment for this bay is listed in the Table 6, including health index value for each item.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-C04-542--2SAA	SURGE ARRESTOR (GAPLESS)	ASEA	XAQ300A2/240	01.07.1987	5
H024-C04-542--2SAB	SURGE ARRESTOR (GAPLESS)	ASEA	XAQ300A2/240	01.07.1987	5
H024-C04-542--2SAC	SURGE ARRESTOR (GAPLESS)	ASEA	XAQ300A2/240	01.07.1987	5
H024-C04-542--5420	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C04-542--5420-1	EARTH SWITCH	MERLIN GERIN	DR	01.07.1978	5
H024-C04-542--5420-2	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C04-542--5420-3	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C04-542--5421	ISOLATOR	EGIC	DR	01.07.1988	4
H024-C04-542--5422	CIRCUIT BREAKER	MITSUBISHI	250-SFM-40B	02.08.1988	7
H024-C04-542--5422CTA	CURRENT TRANSFORMER	GEC ALSTHOM - T&D BALTEAU	CTH245/6	23.10.1997	5
H024-C04-542--5422CTB	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1986	7
H024-C04-542--5422CTC	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1986	7
H024-C04-542--5423	ISOLATOR	EGIC	DR	01.07.1988	4
H024-C04-542--5427	ISOLATOR	EGIC	DR	01.07.1988	4
H024-C04-542--8VTB	CAPACITOR VOLTAGE TRANSFORMER	HAEFELY	CVE300/1050	01.04.1987	4

Table 6

All the primary plant in this bay was installed in 1987 except for A phase CT which was replaced in 1997. The primary plant in this bay is in relatively good condition, however the maintenance records show issues with the circuit breaker.

Similar to the other Mitsubishi 250–SFM-340B circuit breakers in this substation, there are a number of issues identified in the maintenance records. Air compressor unit and pressure relief valve in this CB were replaced. The maintenance record indicated that the Kaji air compressor had a number of low oil levels. Mitsubishi does not produce this type of circuit breaker anymore and sourcing of spare parts has become a major issue. Wiring inside the mechanism box is cracked due to UV penetrating through the viewing window. This CB has been in service for 33 years and it is estimated that it has a remaining service life of 5 years.

The remaining oil filled instrument transformers are in reasonable condition considering they have been in service for 33 years, and the DGA/moisture in oil analysis is satisfactory. There are no identified issues with oil seal integrity. However, considering their age and construction, it is recommended to replace all CTs and the CVT in 5 years to manage potential safety risks.

The associated structures and foundations are in good condition and are expected to have a remaining life of 20 years.

Recommendation: Based on the above observations, it is recommended that CB , CTs and CVT including structures and foundations are replaced within the next 5 years preferably using a dead tank CB.The rest of the HV plant is in good condition and no replacements are required in the next 10 year outlook.

It is recommended to continue monitoring condition of structures and foundations in this bay for another 10-15 years (if not replaced with the equipment) and plan their replacement in 20-30 years.

2.2.6 H024-C04-851- 851 FEEDER BAY

The equipment for this bay is listed in the Table 7, including health index value for each item.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-C04-851--5VTB	CAPACITOR VOLTAGE TRANSFORMER	HAEFELY	IOSK300/1050	01.07.1987	5
H024-C04-851--8510	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C04-851--8510-1	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C04-851--8510-2	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C04-851--8510-3	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C04-851--8512	CIRCUIT BREAKER	MITSUBISHI	250-SFM-40B	02.08.1988	7
H024-C04-851--8512CTA	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1987	7
H024-C04-851--8512CTB	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1987	7
H024-C04-851--8512CTC	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1986	7
H024-C04-851--8513	ISOLATOR	EGIC	DR	01.07.1988	4
H024-C04-851--8517	ISOLATOR	EGIC	DR	01.07.1988	4
H024-C04-851--851CTVTA	COMBINED_CT/VT	HAEFELY TRENCH	SVAS 300/OG	13.05.1997	4
H024-C04-851--851CTVTA	COMBINED_CT/VT	HAEFELY TRENCH	SVAS 300/OG	13.05.1997	4
H024-C04-851--851CTVTA	COMBINED_CT/VT	HAEFELY TRENCH	SVAS 300/OG	13.05.1997	4

Table 7

Similar to the other Mitsubishi 250–SFM-340B circuit breakers in this substation, there are a number of issues identified in the maintenance records. This CB had issues with compressor oil leak ,UV damagaed control cable and preesure relief valaves. This CB has been in service for 33 years and it is estimated that it has a remaining service life of 5 years.

The Haefely oil filled instrument transformers are in satisfactory condition considering they have been in service for 33 years, and the DGA/moisture in oil analysis is satisfactory. There are no identified issues with oil seal integrity. However, considering their age and construction, it is recommended to replace all CTs and the CVT in 5 years to manage potential safety risks.

The associated structures and foundations are in good condition and are expected to have a remaining life of 20 years.

Recommendation: Based on the above observations, it is recommended that CB, CTs and CVT including structures and foundations are replaced within the next 5 years preferably using a dead tank CB.The rest of the HV plant is in good condition and no replacements are required in the next 10 year outlook.

It is recommended to continue monitoring condition of structures and foundations in this bay for another 10-15 years (if not replaced with the equipment) and plan their replacement in 20-30 years.

2.2.7 H024-C05-505- 5 COUPLER BAY

The equipment in this bay is listed in Table 8, including health index value for each item.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-C05-505--5050-1	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	6
H024-C05-505--5050-2	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	6
H024-C05-505--5052	CIRCUIT BREAKER	MITSUBISHI	250-SFM-40B	02.08.1988	7
H024-C05-505--5052CTA	CURRENT TRANSFORMER	GEC ALSTHOM - T&D BALTEAU	CTH245/6	29.10.1997	
H024-C05-505--5052CTB	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1986	7
H024-C05-505--5052CTC	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1987	7
H024-C05-505--5058	ISOLATOR	EGIC	DR	01.07.1988	6
H024-C05-505--5059	ISOLATOR	EGIC	DR	01.07.1988	6

Table 8

Similar to the other Mitsubishi 250–SFM-340B circuit breakers in this substation, there are a number of issues identified in the maintenance records. This CB had issues with compressor oil leak ,UV damaged control cable and SF6 gas leaks .This CB has been in service for 33 years and it is estimated that it has a remaining service life of 5 years.

The A phase CT was replaced in 1997 and appears to be in an acceptable condition. The remaining oil filled CTs are in reasonable condition considering they have been in service for 33 years, and the DGA/moisture in oil analysis is satisfactory. There are no identified issues with oil seal integrity. However, considering their age and construction, it is recommended to replace all CTs in 5 years to manage potential safety risks.

The two isolators 5058 and 5059 installed in this bay have been in service for the last 34 years, are in good condition and maintenance records show no associated problems. The associated structures and foundations are in good condition and are expected to have a remaining life of 20 years.

Recommendation: Based on the above observations, it is recommended that CB and CTs including structures and foundations are replaced within the next 5 years preferably using a dead tank CB.The rest of the HV plant is in good condition and no replacements are required in the next 10 year outlook.

It is recommended to continue monitoring condition of structures and foundations in this bay for another 10-15 years (if not replaced with the equipment) and plan their replacement in 20-30 years.

Figure 13: Wiring UV damages

Figure 14: CB Mech box oil leak

2.2.8 H024-C05-852- 852 FEEDER BAY

The equipment for bay is listed in the Table 9, including health index value for each item.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-C05-852--3VTB	CAPACITOR VOLTAGE TRANSFORMER	HAEFELY	CVE300/1050	01.07.1987	5
H024-C05-852--8520	EARTH SWITCH	MERLIN GERIN	DR	05.07.1999	3
H024-C05-852--8520-1	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C05-852--8520-2	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C05-852--8522	CIRCUIT BREAKER	MITSUBISHI	250-SFM-40B	02.08.1988	7
H024-C05-852--8522CTA	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	20.12.1995	4
H024-C05-852--8522CTB	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1986	7
H024-C05-852--8522CTC	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1986	7
H024-C05-852--8523	ISOLATOR	EGIC	DR	01.07.1988	5
H024-C05-852--8527	ISOLATOR	EGIC	DR	01.07.1988	5
H024-C05-852--852CTVTA	COMBINED_CT/VT	HAEFELY TRENCH	SVAS 300/OG	13.05.1997	4
H024-C05-852--852CTVTB	COMBINED_CT/VT	HAEFELY TRENCH	SVAS 300/OG	13.05.1997	4
H024-C05-852--852CTVTC	COMBINED_CT/VT	HAEFELY TRENCH	SVAS 300/OG	13.05.1997	4

Table 9

Similar to the other Mitsubishi 250–SFM-340B circuit breakers in this substation, there are a number of issues identified in the maintenance records. This CB had issues with compressor oil leaks and UV damaged control cable.This CB has been in service for 33 years and it is estimated that it has a remaining service life of 5 years.

The A phase CT was replaced in 1995 and appears to be in an acceptable condition. The remaining oil filled CTs are in reasonable condition considering they have been in service for 33 years, and the DGA/moisture in oil analysis is satisfactory. There are no identified issues with oil seal integrity. However, considering their age and construction, it is recommended to replace all CTs in 5 years to manage potential safety risks.

The associated structures and foundations are in good condition and are expected to have a remaining life of 20 years.

Recommendation: Based on the above observations, it is recommended that CB , CTs and CVT including structures and foundations are replaced within the next 5 years preferably using a dead tank CB. The rest of the HV plant is in good condition and no replacements are required in the next 10 year outlook.

It is recommended to continue monitoring condition of structures and foundations in this bay for another 10-15 years (if not replaced with the equipment) and plan their replacement in 20-30 years.

2.2.9 H024-C05-871- 871 FEEDER BAY

The equipment for bay is listed in the Table 10, including health index value for each item.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-C05-871--4VTB	CAPACITOR VOLTAGE TRANSFORMER	HAEFELY	CVE300/1050	01.07.1987	5
H024-C05-871--4VTSB	CAPACITOR VOLTAGE TRANSFORMER	HAEFELY	CVE300/1050	01.01.1985	5
H024-C05-871--4VTSC	CAPACITOR VOLTAGE TRANSFORMER	HAEFELY	CVE300/1050	01.01.1985	5
H024-C05-871--8710	EARTH SWITCH	MERLIN GERIN	DR	05.07.1999	5
H024-C05-871--8710-1	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C05-871--8710-2	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C05-871--8710-3	EARTH SWITCH	MERLIN GERIN	DR	01.07.1987	5
H024-C05-871--8711	ISOLATOR	EGIC	DR	01.07.1988	5
H024-C05-871--8712	CIRCUIT BREAKER	MITSUBISHI	250-SFM-40B	02.08.1988	7
H024-C05-871--8712CTA	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	20.12.1995	3
H024-C05-871--8712CTB	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1986	7
H024-C05-871--8712CTB	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	01.01.1986	7
H024-C05-871--8713	ISOLATOR	EGIC	DR	01.07.1988	5
H024-C05-871--8717	ISOLATOR	EGIC	DR	01.07.1988	5
H024-C05-871--871CDA	COUPLING DEVICE PLC PHASE TO PHASE	HAEFELY TRENCH	ESV6		
H024-C05-871--871CDB	COUPLING DEVICE PLC PHASE TO PHASE	HAEFELY TRENCH	ESV6		

Table 10

Similar to the other Mitsubishi 250–SFM-340B circuit breakers in this substation, there are a number of issues identified in the maintenance records. This CB had issues with compressor oil leak ,UV damagaed control cable and SF6 gas leaks .This CB has been in service for 33 years and it is estimated that it has a remaining service life of 5 years.

The A phase CT was replaced in 1995 and appears to be in an acceptable condition. The remaining oil filled instrument transformers are in reasonable condition considering they have been in service for 33 years, and the DGA/moisture in oil analysis is satisfactory. There are no identified issues with oil seal integrity. However, considering their age and construction, it is recommended to replace all CTs and the CVT in 5 years to manage potential safety risks.

The associated structures and foundations are in good condition and are expected to have a remaining life of 20 years.

Recommendation: Based on the above observations, it is recommended that CB, CTs and CVT including structures and foundations are replaced within the next 5 years preferably using a dead tank CB. The rest of the HV plant is in good condition and no replacements are required in the next 10 year outlook.

It is recommended to continue monitoring condition of structures and foundations in this bay for another 10-15 years (if not replaced with the equipment) and plan their replacement in 20-30 years.

2.2.10 H024-C06-506- 6 COUPLER BAY

The equipment in this bay is listed in Table 11, including health index value for each item.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-C06-506--5060-1	EARTH SWITCH	ABB ELPAR	TEC	18.01.2000	2
H024-C06-506--5060-2	EARTH SWITCH	NGK STANGER	VSB	19.11.1998	3
H024-C06-506--5062	CIRCUIT BREAKER	ABB SWEDEN	HPL300B1 3PAR	01.07.1998	7
H024-C06-506--5062CTA	CURRENT TRANSFORMER	TRENCH	SAS 300/9G	24.09.2015	1
H024-C06-506--5062CTB	CURRENT TRANSFORMER	TRENCH	SAS 300/9G	24.09.2015	1
H024-C06-506--5062CTC	CURRENT TRANSFORMER	TRENCH	SAS 300/9G	24.09.2015	1
H024-C06-506--5068	ISOLATOR	NGK STANGER	HCB	19.11.1998	3
H024-C06-506--5069	ISOLATOR	ABB ELPAR	SGF300p100+2E	18.01.2000	3

Table 11

The circuit breaker in this bay was installed in 1998. It is an ABB model HPL 300/25 B1. It has a 240V AC operating mechanism with spring used for energy storage and SF6 for insulating medium. The maintenance records shows a history of SF6 leaks and it has been topped up several times with SF6. Gas leak found coming from B and C phase gauges in 2016. There are 44 circuit breakers of this type in service currently. Eighteen of these have developed gas leaks and at least four poles have had to be replaced. There are only two spare poles available in stock and refurbishing/repairing these CBs has not proven to be cost effective.There are six of this type of CB's in service at Calvale. The recommended strategy for these ABB CBs is to replace those that are already leaking and recover good poles of replaced CBs to increase spare holdings to assist in managing others in the fleet

All other primary plant in this bay is in good condition. The SF6 CTs in this bay were installed in 2015 as a part of twin leg CT replacements.

The associated structures and foundations in this bay have a remaining service life of 40 years, except the CT structure & foundation which have an estimated remaining service life of 50 years.

Recommendation: Based on the above observations, it is recommended that the CB including structures and foundations is replaced within the next 5 years. If a deadtank CB is installed the CTs can be recovered and used as system spares. The rest of the HV plant is in good condition and no replacements are required in the next 10 year outlook.

2.2.11 H024-C06-853- 853 FEEDER BAY

The equipment for this bay is listed in the Table 12, including health index value for each item.

The circuit breaker in this bay was installed in 1998 and is an ABB model HPL 300/25 B1, of which some exhibited issues with SF6 leaks due to an inherent manufacturing defect. Maintenance records show that an SF6 leak was detected on A phase, which has had several top ups of SF6. Leaking was unable to be stopped. This CB has leaked SF6 gas since 2006 and required topping up of gas almost every year.

The associated structures and foundations are in good condition and are expected to have a remaining life of 40 years except the CT structure which has a 50 years life.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-C06-853--14VTA	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TCVT300C	05.11.2016	1
H024-C06-853--14VTB	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TCVT300C	21.11.2019	2
H024-C06-853--14VTC	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TCVT300C	05.11.2016	1
H024-C06-853--8530	EARTH SWITCH	ABB ELPAR	TEC	28.02.2000	3
H024-C06-853--8530-1	EARTH SWITCH	NGK STANGER	VSB	19.11.1998	3
H024-C06-853--8530-2	EARTH SWITCH	ABB ELPAR	TEC	28.02.2000	3
H024-C06-853--8532	CIRCUIT BREAKER	ABB SWEDEN	HPL300/25B1 SPAR P	04.12.1998	7
H024-C06-853--8532-CTA	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	01.10.2015	1
H024-C06-853--8532-CTB	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	01.10.2015	1
H024-C06-853--8532-CTC	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	01.10.2015	1
H024-C06-853--8533	ISOLATOR	NGK STANGER	HCB	19.11.1998	3
H024-C06-853--8537	ISOLATOR	ABB ELPAR	SGF300p100+1E	28.02.2000	4

Table 12

Recommendation: Based on the above observations, it is recommended that CB including structures and foundations is replaced within the next 5 years. If a deadtank CB is installed the CTs can be recovered and used as system spares. The rest of the HV plant is in good condition and no replacements are required in the next 10 year outlook.

2.2.12 H024-C06-8810- 8810 FEEDER BAY

The equipment for this bay is listed in Table 13, including health index value for each item.

This bay was installed in 1998. Most the primary plant in this bay is in relatively good condition and maintenance records show only minor issues with isolator 88109 which is not able to be opearated electrically but needs to be opened manually.

The two ABB HPL300 CBs have been in service for 21 years, and both developed gas leaks in 2006 requiring frequent topping up with SF6 gas.

The associated structures and foundations are in good condition and are expected to have a remaining life of 40 years except CT which has a 50 year life.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-C06-8810-12VTA	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TCVT300C	29.03.2019	2
H024-C06-8810-12VTB	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TCVT300C	29.03.2019	2
H024-C06-8810-12VTC	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TCVT300C	29.03.2019	2
H024-C06-8810-88100	EARTH SWITCH	ABB ELPAR	TEC	28.02.2000	3
H024-C06-8810-88100-1	EARTH SWITCH	NGK STANGER	VSB	19.11.1998	3
H024-C06-8810-88100-2	EARTH SWITCH	NGK STANGER	VSB	19.11.1998	3
H024-C06-8810-88100-3	EARTH SWITCH	NGK STANGER	VSB	19.11.1998	3
H024-C06-8810-88100-4	EARTH SWITCH	NGK STANGER	VSB	19.11.1998	3
H024-C06-8810-88101	ISOLATOR	NGK STANGER	HCB	18.11.1998	3
H024-C06-8810-88102	CIRCUIT BREAKER	ABB SWEDEN	HPL300/25B1 SPAR P	04.12.1998	7

H024-C06-8810-88102-1	CIRCUIT BREAKER	ABB TRANSMISSION &DISTRIBUTION	HPL300/25B1 SPAR P	04.12.1998	7
H024-C06-8810-88102CTA	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	22.10.2015	1
H024-C06-8810-88102CTB	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	22.10.2015	1
H024-C06-8810-88102CTC	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	22.10.2015	1
H024-C06-8810-88103	ISOLATOR	NGK STANGER	HCB	19.11.1998	4
H024-C06-8810-88107	ISOLATOR	ABB ELPAR	SGF300p100+1E	28.02.2000	2
H024-C06-8810-88109	ISOLATOR	NGK STANGER	HCB	19.11.1998	3
H024-C06-8810-8810RSAA	SURGE ARRESTOR (GAPLESS)	COOPER POWER SYSTEMS	AZG3025G190240	19.11.1998	3
H024-C06-8810-8810RSAB	SURGE ARRESTOR (GAPLESS)	COOPER POWER SYSTEMS	AZG3025G190240	19.11.1998	3
H024-C06-8810-8810RSAC	SURGE ARRESTOR (GAPLESS)	COOPER POWER SYSTEMS	AZG3025G190240	19.11.1998	3
H024-C06-8810-8810SAA	SURGE ARRESTOR (GAPLESS)	COOPER POWER SYSTEMS	AZG3025G190240	19.11.1998	3
H024-C06-8810-8810SAB	SURGE ARRESTOR (GAPLESS)	COOPER POWER SYSTEMS	AZG3025G190240	19.11.1998	3
H024-C06-8810-8810SAC	SURGE ARRESTOR (GAPLESS)	COOPER POWER SYSTEMS	AZG3025G190240	19.11.1998	3

Table 13

Recommendation: Based on the above observations, it is recommended that CBs 88102 & 88102-1 including structures and foundations are replaced within the next 5 years. If a deadtank CB is installed the CTs can be recovered and used as system spares. The rest of the HV plant is in good condition and no replacements are required in the next 10 year outlook.

2.2.13 H024-C07-507- 7 COUPLER BAY

The equipment in this bay is listed in Table 14, including health index value for each item.

All the primary plant in this bay was installed in 1998. The CTs in this bay were replaced in 2015 as part of the twin leg CTs replacement project OR.01759. All other primary plant in this bay is in good condition.

The associated structures and foundations in this bay have a remaining service life of 40 years, except the CT structure & foundation which have an estimated remaining service life of 50 years.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-C07-507--5070-1	EARTH SWITCH	ABB ELPAR	TEC	18.01.2000	3
H024-C07-507--5070-2	EARTH SWITCH	NGK STANGER	VSB	19.11.1998	3
H024-C07-507--5072	CIRCUIT BREAKER	ABB SWEDEN	HPL300B1 3PAR	19.11.1998	4
H024-C07-507--5072CTA	CURRENT TRANSFORMER	TRENCH	SAS 300/9G	29.04.2015	1
H024-C07-507--5072CTB	CURRENT TRANSFORMER	TRENCH	SAS 300/9G	29.04.2015	1
H024-C07-507--5072CTC	CURRENT TRANSFORMER	TRENCH	SAS 300/9G	29.04.2015	1
H024-C07-507--5078	ISOLATOR	NGK STANGER	HCB	19.11.1998	
H024-C07-507--5079	ISOLATOR	ABB ELPAR	SGF300p100+2E	18.01.2000	3

Table 14

Recommendation: Based on the above observations, all the primary plant in this bay is in good condition and no replacements are recommended in the next 20 year outlook.

2.2.14 H024-C07-854- 854 FEEDER BAY

The equipment for this bay is listed in the Table 15, including health index value for each item.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-C07-854--15VTA	CAPACITOR VOLTAGE TRANSFORMER	HAEFELY TRENCH	TEMP287	05.03.2000	4
H024-C07-854--15VTB	CAPACITOR VOLTAGE TRANSFORMER	HAEFELY TRENCH	TEMP287	05.03.2000	4
H024-C07-854--15VTC	CAPACITOR VOLTAGE TRANSFORMER	HAEFELY TRENCH	TEMP287	05.03.2000	4
H024-C07-854--8540	EARTH SWITCH	ABB ELPAR	TEC	05.03.2000	3
H024-C07-854--8540-1	EARTH SWITCH	NGK STANGER	VSB	19.11.1998	3
H024-C07-854--8540-2	EARTH SWITCH	ABB ELPAR	TEC	05.03.2000	3
H024-C07-854--8542	CIRCUIT BREAKER	ABB SWEDEN	HPL300/25B1 SPAR P	04.12.1998	5
H024-C07-854--8542-CTA	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	15.04.2015	1
H024-C07-854--8542-CTB	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	15.04.2015	1
H024-C07-854--8542-CTC	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	15.04.2015	1
H024-C07-854--8543	ISOLATOR	NGK STANGER	HCB	19.11.1998	3
H024-C07-854--8547	ISOLATOR	ABB ELPAR	SGF300p100+1E	28.02.2000	3

Table 15

This bay was built in 2000 as part of project CP.00763 and all the primary plant in this bay is in good condition. The CT were replace in 2015 and associated structures and expected to have a remaining life of 50 years foundations.

The associated structures and foundations are in good condition and are expected to have a remaining life of 40 years.

Recommendation: Based on the above observations, the primary plant in this bay is in good condition and no replacements are required in the next 10 year outlook.

2.2.15 H024-C07-8811- 8811 FEEDER BAY

The equipment for this bay is listed in the Table 16, including health index value for each item.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-C07-8811-13VTA	CAPACITOR VOLTAGE TRANSFORMER	HAEFELY TRENCH	TEMP287	19.11.1998	4
H024-C07-8811-13VTB	CAPACITOR VOLTAGE TRANSFORMER	HAEFELY TRENCH	TEMP287	19.11.1998	4
H024-C07-8811-13VTC	CAPACITOR VOLTAGE TRANSFORMER	HAEFELY TRENCH	TEMP287	19.11.1998	4
H024-C07-8811-88110	EARTH SWITCH	NGK STANGER	VSB	19.11.1998	3
H024-C07-8811-88110-1	EARTH SWITCH	NGK STANGER	VSB	19.11.1998	3
H024-C07-8811-88110-2	EARTH SWITCH	NGK STANGER	VSB	19.11.1998	3
H024-C07-8811-88110-3	EARTH SWITCH	NGK STANGER	VSB	19.11.1998	3
H024-C07-8811-88110-4	EARTH SWITCH	NGK STANGER	VSB	19.11.1998	3
H024-C07-8811-88111	ISOLATOR	NGK STANGER	HCB	18.11.1998	4
H024-C07-8811-88112	CIRCUIT BREAKER	ABB SWEDEN	HPL300/25B1 SPAR P	04.12.1998	5

H024-C07-8811-88112-1	CIRCUIT BREAKER	ABB TRANSMISSION &DISTRIBUTION	HPL300/25B1 SPAR P	04.12.1998	7
H024-C07-8811-88112CTA	CURRENT TRANSFORMER (OIL)	ABB AUSTRALIA	IMB300C6H4	12.10.2014	4
H024-C07-8811-88112CTB	CURRENT TRANSFORMER (OIL)	ABB AUSTRALIA	IMB300C6H4	12.10.2014	4
H024-C07-8811-88112CTC	CURRENT TRANSFORMER (OIL)	ABB AUSTRALIA	IMB300C6H4	12.10.2014	4
H024-C07-8811-88113	ISOLATOR	NGK STANGER	HCB	19.11.1998	4
H024-C07-8811-88117	ISOLATOR	NGK STANGER	HCB	19.11.1998	4
H024-C07-8811-88119	ISOLATOR	NGK STANGER	HCB	19.11.1998	4
H024-C07-8811-8811RSAA	SURGE ARRESTOR (GAPLESS)	COOPER POWER SYSTEMS	AZG3025G190240	19.11.1998	3
H024-C07-8811-8811RSAB	SURGE ARRESTOR (GAPLESS)	COOPER POWER SYSTEMS	AZG3025G190240	19.11.1998	3
H024-C07-8811-8811RSAC	SURGE ARRESTOR (GAPLESS)	COOPER POWER SYSTEMS	AZG3025G190240	19.11.1998	3
H024-C07-8811-8811SAA	SURGE ARRESTOR (GAPLESS)	COOPER POWER SYSTEMS	AZG3025G190240	19.11.1998	3
H024-C07-8811-8811SAB	SURGE ARRESTOR (GAPLESS)	COOPER POWER SYSTEMS	AZG3025G190240	19.11.1998	3
H024-C07-8811-8811SAC	SURGE ARRESTOR (GAPLESS)	COOPER POWER SYSTEMS	AZG3025G190240	19.11.1998	3

Table 16

This bay was built in 1998 all the primary plant in this bay is relatively new and in good condition. Both ABB HPL300 CBs have been in service for 21 years and both developed gas leaks in 2008 requiring frequent topping up with SF6 gas.

The associated structures and foundations are in good condition and are expected to have a remaining life of 40 years.

Recommendation: Based on the above observations, it is recommended that both ABB CBs including structures and foundations are replaced within the next 5 years. If a deadtank CB is installed the CTs can be recovered and used as system spares. The rest of the HV plant is in good condition and no replacements are required in the next 10 year outlook.

2.2.16 H024-D04-442- 132kV 2 TRANSFORMER BAY

The equipment for this bay is listed in the Table 17, including health index value for each item.

All the primary plant in this bay was installed in 1987. All the primary plant in this bay is in relatively good condition.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-D04-442--2SAA	SURGE ARRESTOR (GAPLESS)	HITACHI	ZLA-X15S	01.07.1987	5
H024-D04-442--2SAB	SURGE ARRESTOR (GAPLESS)	HITACHI	ZLA-X15S	01.07.1987	5
H024-D04-442--2SAC	SURGE ARRESTOR (GAPLESS)	HITACHI	ZLA-X15S	01.07.1987	5
H024-D04-442--4420	EARTH SWITCH	SIEMENS	SSB111-145	01.07.1977	5
H024-D04-442--4421	ISOLATOR	SIEMENS	SSBIII-145	01.07.1988	5
H024-D04-442--9VTC	CAPACITOR VOLTAGE TRANSFORMER	HAEFELY	CVE145/650	01.07.1987	5

Table 17

Recommendation: Based on the above observations, the primary plant in this bay is in good condition and no replacements are required in the next 10-15 year outlook.

2.3 Bus Diameters

2.3.1 275kV & 132kV Bus Diameters

The equipment associated with both 275kV & 132kV buses are listed in Table 18, including a health index value for each item.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-KC1-1BU5-1SAA	SURGE ARRESTOR (GAPLESS)	HITACHI	ZLA-X25C	01.01.1986	5
H024-KC1-1BU5-1SAB	SURGE ARRESTOR (GAPLESS)	HITACHI	ZLA-X25C	01.01.1986	5
H024-KC1-1BU5-1SAC	SURGE ARRESTOR (GAPLESS)	HITACHI	ZLA-X25C	01.01.1986	5
H024-KC1-1BU5-1VTB	CAPACITOR VOLTAGE TRANSFORMER	HAEFELY	CVE300/1050	05.07.1999	4
H024-KC1-1BU5-5910	EARTH SWITCH	MERLIN GERIN	DR	01.07.1977	5
H024-KC2-2BU5-2SAA	SURGE ARRESTOR (GAPLESS)	HITACHI	ZLA-X25C	01.01.1986	5
H024-KC2-2BU5-2SAB	SURGE ARRESTOR (GAPLESS)	HITACHI	ZLA-X25C	01.01.1986	5
H024-KC2-2BU5-2SAC	SURGE ARRESTOR (GAPLESS)	HITACHI	ZLA-X25C	01.01.1986	5
H024-KC2-2BU5-2VTB	CAPACITOR VOLTAGE TRANSFORMER	HAEFELY	CVE300/1050	05.07.1999	4
H024-KC2-2BU5-5920	EARTH SWITCH	MERLIN GERIN	DR	01.07.1977	6
H024-KD3-3BU4-4930	EARTH SWITCH	ALSTOM		29.03.2019	1

Table 18

In both 275kV & 132kV yards bus support structures have been built as lattice type structures and tubular poles. The bus support post insulators are in very good condition and the associated structures and foundations in these buses are in good condition. However a number of the structures were identified to have advanced corrosion of the bolts. It is recommended to replace all corroded bolts.

The lattice structures and foundations installed in late 1990s and 2000s were tubular structures which have an estimated remaining service life of 20 years. The rest of the tubular structures and foundations have an estimated remaining service life of 40 years.

Lattice structures were used as bus supports in the initial construction while in the late 1990s and 2000s tubular structures were used. All structures are in good condition and no significant issues were found. Examples of the lattice and tubular structures are shown in Figures 15 and 16 respectively.

Figure 15: 275kV Lattice Bus Support Structure

Figure 16: 275kV Tubular Bus Support Structure

The 132kV bus support structures were established in 2019 and are in as new condition. The structures support all three phases as shown in Figures 17 and 18.

.

Figure 17: 132kV Bus Support Structure

Figure 18: 275kV Tubular Bus Support Structure

Recommendation: The corroded bolts on all structures are recommended to be replaced immediately. Apart from this, based on the above observations, the primary equipment in these bays is in good condition and no replacements are required in the next 10-15 year outlook.

2.4 Strung Bus and Structures

From ground level both 275kV & 132kV strung bus conductors and connectors over the bays appear to be in good condition.

The overhead earth wire appears to be in good condition. The connections of the earth wire to their strain towers vary in configuration but these are also in good condition. Refer to Figure 16 and 17

Figure 19: Earth wire

Figure 20: strung bus conductors

The 275kV strain structures were established between 1984 and 2013. All 275 kV strain structures are the same lattice type as shown in Figures 18 to 19. No issues related to the structures were found.

Figure 21: 275kV Strain Structure

Figure 22: 275kV Structure Main Leg

2.5 Site Infrastructure

2.5.1 AC supply transformers

There are two AC supplies, one is via 19.1/0.433 kV auxiliary transformer connected to the tertiary of power transformer T2 and other connected to H030 Callide B 6.6kV board via a 6.6/0.433 kV auxiliary transformer. These provide adequate and reliable local supply for this substation.

These two station transformers are in good condition. However the 4 station transformer is 44 year old and is at the end of its technical service life where condition is expected to deteriorate rapidly.

Figure 23: 3 Stn Transformer

Figure 24: 4 Stn Transformer

Figure 25: Diesel generator

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H024-SIN-ACSU-3STN	LOCAL SUPPLY TRF	TYREE	MODEL396	05.07.1999	3
H024-SIN-ACSU-4TRF	LOCAL SUPPLY TRF	WILSON		01.07.1976	6
H024-SIN-DIES-1DIESEL	1 DIESEL ALTERNATOR	GENELITE		24.01.2019	1

Table 19

Recommendation: Based on the above observations, the station transformer 4 is recommended for replacement within next 5 years along with associated cables.

2.5.2 AC Changeover board

The AC changeover board was installed under project CP.01151 and is in good condition.

Figure 26: AC changeover board

Recommendation: Based on the above observations and records, there is no action required in the next 10 years outlook, apart from normal maintenance.

2.5.3 Security Fence

The substation security fence was upgraded to an electric fence in 2017.

The substation security fence consists of a standard chain wire fence and an electrical fence mounted on the inside of the chain wire fence. The chain wire fence is approximately 3m tall, has a bottom rail and barbed wires at the top. At the base of the fence is a concrete strip in line with Powerlink's standard requirements. The fence is in good condition and its civil aspects should provide about 20 year life before significant repairs are required. A section of the fence is shown in Figure 27.

Figure 27: Security Fence

2.5.4 Substation Access and Internal Roads

The Calvale Substation is accessed from Biloela Callide Rd, Biloela. This is a suburban road with good visibility of the entrance shown in Figure 28.

Figure 28: Substation access from Biloela Callide Rd

The access road through Powerlink's property between the road gate and the substation security gate is sealed and in good condition. The security gate and fence were not inspected due to the planned security fence upgrade project.

The substation internal roads are in a reasonable condition although broken in some areas. In particular the road surface is broken in the vicinity of the entry gate as shown in Figure 29.

Figure 29: Broken road surface

Recommendation: Based on the above observations and records, there is no action required in the next 10-15 year outlook, apart from normal maintenance.

2.5.5 Substation Yard, Platform and Site Drainage System

The substation platform is covered in gravel and is generally well maintained. Some evidence of minor surface water pooling was observed on the platform, however identifying any drainage issues was unlikely as the inspection occurred in dry weather.

2.5.6 Cable Trenches

There is no indication in the maintenance records of any issues related to the cable trench covers. They are generally in good condition with occasional gaps between covers and some bent covers that were obviously driven over. These should be rectified through condition based maintenance.

2.5.7 Yard Lights

The switchyard lights are weatherproof low level floodlights.

2.5.8 Substation earthing

2.5.8.1.1 Structure and equipment earthing

The lowest rated earth tail is suitable to conduct fault current of 42 kA for 100 ms, which is suitable for current fault level for this site.


Figure 30: no tail to fence

The fence post should be connect to the main earth grid at the grid crossings, it was noticed on site that this was not the case.

2.5.8.1.2 Earth grid

A grid injection test was performed in August 2018 and the results were satisfactory. However the earth grid design report (objective ID A2984746) recommended that gravel surfacing be completed inside the north eastern fence and the south western gate and an asphalt strip placed outside these areas as a minimum and ideally gravel throughout and the asphalt around the entire yard. It appears that this recommendation was not done. The current gravel layer installed inside the substation appears to be for current plant maintenance strategies not for earthing.

The earth grid is rated for fault currents up to 19 kA for 500 ms.

Figure 31: Gravel in the yard

Figure 32: Asphalt along part of the outside

3. EQUIPMENT REPLACEMENT RECOMMENDATION - OVERVIEW

In addition to the above mentioned recommended maintenance actions, it is recommended to replace below listed equipment in the next 5 year outlook. It is necessary to confirm the enduring need for this equipment prior to initiation of a replacement project.

Asset	Action Req. (Y/N)	Asset Replc. Recom. (Y/N)	Refurb. Recom. (Y/N)	Corr. Maint. Rec. (Y/N)	Comments
H024-C03-503	Y	Y (5 yrs)	Y	N	Replace CB and CTs in 5 years.
H024-C03-541	Y	Y (5 yrs)	Y	N	Replace CB , CTs & CVT in 5 years
H024-C03-8874	Y	Y (5 yrs)	Y	N	Replace CB and CTs in 5 years.
H024-C04-504	Y	Y (5 yrs)	Y	N	Replace CB and CTs in 5 years.
H024-C04-542	Y	Y (5 yrs)	Y	N	Replace CB , CTs & CVT in 5 years
H024-C04-851	Y	Y (5 yrs)	Y	N	Replace CB , CTs & CVT in 5 years
H024-C05-505	Y	Y (5 yrs)	Y	N	Replace CB and CTs in 5 years.
H024-C05-852	Y	Y (5 yrs)	Y	N	Replace CB , CTs & CVT in 5 years
H024-C05-871	Y	Y (5 yrs)	Y	N	Replace CB , CTs & CVT in 5 years
H024-C06-506	N	Y (5 yrs)	N	N	Replace CB in 5 years
H024-C06-853	N	Y (5 yrs)	N	N	Replace CB in 5 years
H024-C06-8810	N	Y (5 yrs)	N	N	Replace CB in 5 years
H024-C06-8810-1	N	Y (5 yrs)	N	N	Replace CB in 5 years
H024-C07-507	N	N	N	N	-
H024-C07-854	N	N	N	N	-
H024-C07-8811	N	N	N	N	-
H024-C07-8811-1	N	Y (5 yrs)	N	N	Replace CB in 5 years
H024-D03-7019	N	N	N	N	-
H024-D04-442	N	N	N	N	-
1 BUS DIAMETER	N	N	N	N	-
2 BUS DIAMETER	N	N	N	N	-
BUILDINGS	N	N	N	N	-
AC SUPPLY	N	N	Y (5 yrs)	N	Replace Station 4 Transformer
DC SUPPLY	N	N	N	N	-

Table 20

3.1 Conclusions

The strategy for H024 Calvale Substation in the next 5 years outlook includes a mix of maintenance activities and replacement of nominated high voltage equipment and infrastructure as per the above Table. Revealed issues related to the plant condition, unavailability of spares and therefore the inability to maintain the existing equipment. A high number of damaged porcelain insulators were also found on site. All of these represent risks to the provision of reliable supply and to safety of both personnel and public. Each risk is different and has a difference consequence, from minor to extreme. To manage the worst of these risks, replacement of some plant should be undertaken within next 5 years at the latest. Appropriate maintenance activities will be required to manage the remaining risks.

4. APPENDIX

Appendix No.1

- Asbestos Register (Objective Id A1999585)

Other reference information

- *Civil condition assessment report (Objective Id A3296102).*
- *Equipment list (SAP)*
- *Notifications, work orders and measurement documents (SAP)*
- *275kV & 132kV operating diagram*
- *Switchyard earth grid layouts*
- *Equipment, bay and feeder ratings*
- *Discussions with Powerlink technical staff*
- *Discussions with the maintenance service provider*
- *Relevant Powerlink drawings*

4.1 Health Index Methodology

The condition of all high voltage equipment within a bay is assessed based on visual inspection performed by a suitable qualified engineer and available measurable data. This assessed condition is translated into a 'health index' to provide a comparable tool to indicate expected remaining life of each item of equipment based on its condition, rather than its nameplate age.

The individual health index of each item of equipment within a bay is then used to derive a 'reinvestment index' for the bay (asset level). The methodology used to collate health indices into a reinvestment index considers the complexity of the equipment replacement together with the potential equipment failure modes and severity of consequences. It also includes impact of any identified compliance issues.

The reinvestment index provides an overall tool to compare primary assets (switching bays) within a substation to provide a guide to when intervention is expected to be necessary. Based on the enduring need assessment, the intervention may take the form of decommissioning, significant refurbishment or life extension of existing assets, or selected/full replacement of assets on a like-for-like basis with modern equivalent equipment that is likely to have reduced failure consequences.

Although the health index (HI) and reinvestment index (RI) is used to trigger subsequent actions, the timing of intervention is based upon a risk cost analysis, while the nature of the intervention is determined by undertaking an economic assessment of all identified feasible options to address the condition risks.

HI / RI	Estimated Remaining Life (years)	Action (excl. routine and condition based maintenance activities)	Condition Overview
10	1 -2	Annual inspection and review of condition assessment (CA) required or special maintenance regime implemented to manage condition risks.	**Poor condition – needs urgent action.**
9	2-3		Poor condition – needs prompt, planned action.
8	3 - 5		Poor condition – needs planned action (intervention or condition monitoring)
7	5 - 10	Review and update CA to monitor aging and degradation of equipment. Project scope initiated.	Deteriorating condition – future planned replacement required.
6	10 - 20	Detailed CA trigger.	Deteriorating condition – future planned replacement needs to be considered and timing confirmed.
5	20 - 25	Plan detailed CA in 5 years.	Satisfactory condition – may need some mid-life refurbishment activities.
4	25 - 30	Mid-life CA (desktop) trigger – review maintenance notifications.	Satisfactory condition.
3	30 - 35	Annual review of HI and RI begins.	Good condition
2	35 - 40	Annual review of notifications – dealing with infant mortality issues.	Good condition.
1	≥40	None	New.

Table 21: HI Methodology Overview

Planning Statement	22/04/2020
Title	CP.xxxxx – H024 Calvale Substation Selective Replacement of Primary Plant – Planning Statement [1]
Zone	Central West
Need Driver	Network and safety risks arising from the condition of ageing primary plant, with an estimated 2025 end of life.
Network Limitation	Calvale Substation is required to maintain power transfer capabilities out of Central West Queensland to load centres in Gladstone and Southern Queensland and to meet Powerlink Queensland's N-1-50MW/600MWh reliability obligations in the local area.
Pre-requisites	None

Executive Summary

Calvale Substation is a bulk supply point for Moura and Biloela Substations and provides an essential switching service for the flow of energy between Central-West Queensland and load centres in Southern Queensland (SQ) and Gladstone, as well as the transfer of energy from generators in North Queensland (NQ).

Energy Queensland's forecasts show an enduring need for the supply of electricity to loads in Biloela and Moura.

Emerging primary-plant condition risks at H024 Calvale Substation require Powerlink to take action in order to continue to meet its Transmission Authority reliability obligations for Moura and Biloela and avoid constraining the transfer of energy to load centres in SQ and Gladstone.

The preferred network solution for Powerlink to continue to meet its statutory obligations is the replacement of the at-risk primary plant by June 2025.

[1] *This report contains confidential information, which is the property of Powerlink, and the Registered Participant mentioned in the report, and has commercial value. It qualifies as Confidential Information under the National Electricity Rules (NER). The NER provides that Confidential Information:*

- *must not be disclosed to any person except as permitted by the NER;*
- *must only be used or copied for the purpose intended in this report;*
- *must not be made available to unauthorised persons*

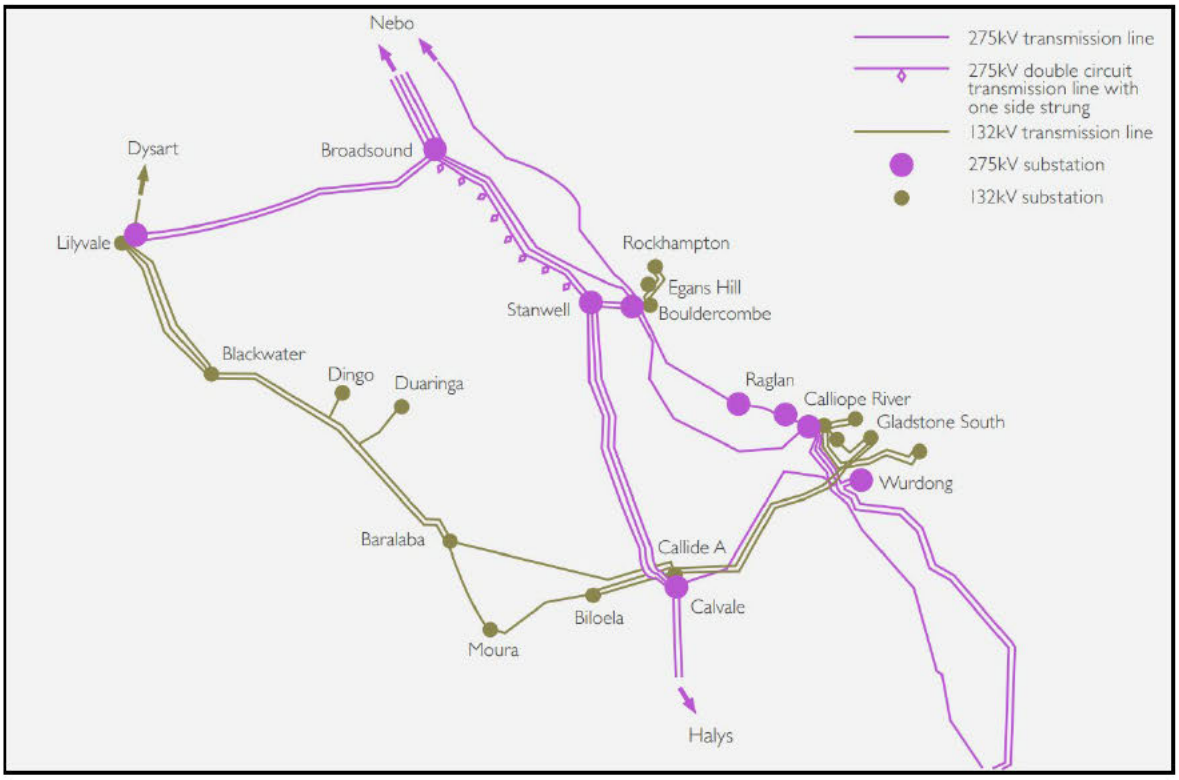
Table of Contents

1. Introduction

Calvale Substation provides an essential switching service for the transfer of energy between the Central-West, Southern Queensland, Gladstone and North Queensland grid sections. It also serves as the bulk supply point for Biloela and Moura and the point of connection for Callide generators.

The substation was established in the mid-1980s with two 275kV generator connections for the Callide B Power Station and connecting feeders to Wurdong and Stanwell substations at 275kV and Callide A Substation at 132kV. The Calvale Substation was subsequently extended in 1998 for the connection of Callide C Power Station and the double circuit 275kV line to Tarong. Further extension was undertaken in 2013 to include additional bays for the Stanwell 275kV double circuit line.

Figure 1 – Calvale Substation in Central Queensland



A February 2020 condition assessment of the primary plant at H024 Calvale Substation has concluded many of the original assets are reaching the end of their operational life and recommends that action is taken to address the network and safety risks arising from the condition of the ageing plant.

This report assesses the impact that removal of the at-risk plant 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 Calvale Substation.

2. Calvale Demand Forecast

Calvale Substation has two 275/132kV transformers supporting the delivery of power to loads in Biloela and Moura. An outage of the both 275/132kV transformers at Calvale Substation will result in the loss of all loads and generators connected to the substation's 132kV network.

Figure 2 is the duration curve for the loads connected to Calvale's 132kV network.

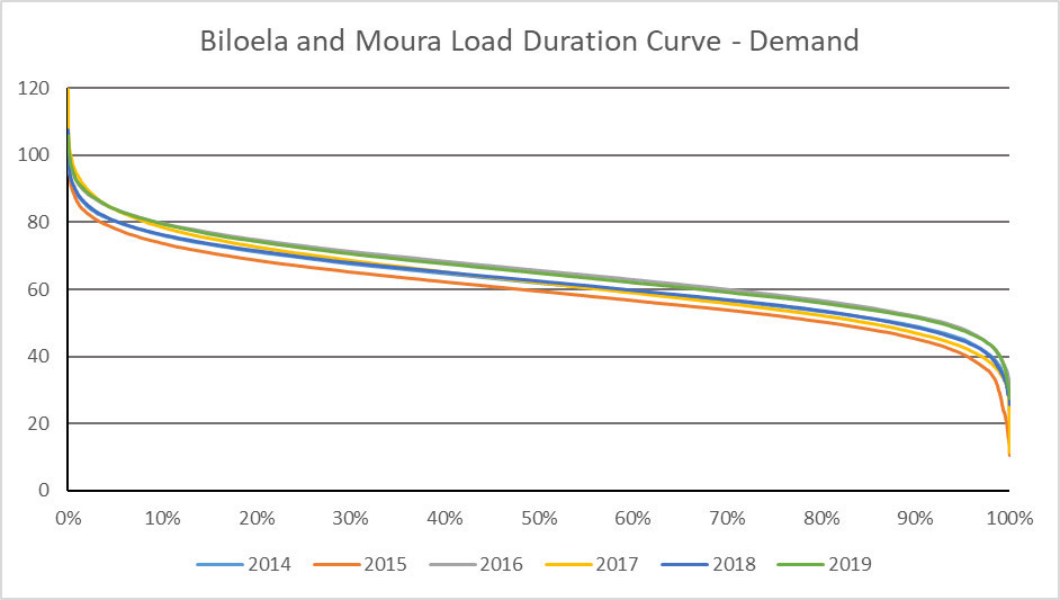


Figure 2 – Calvale 132kV Load Duration Curve

Historical maximum demand information of Moura and Biloela load was plotted with forecasted maximum demand in Figure 3. Over the next 10 years, the maximum demand is forecasted to remain steady.

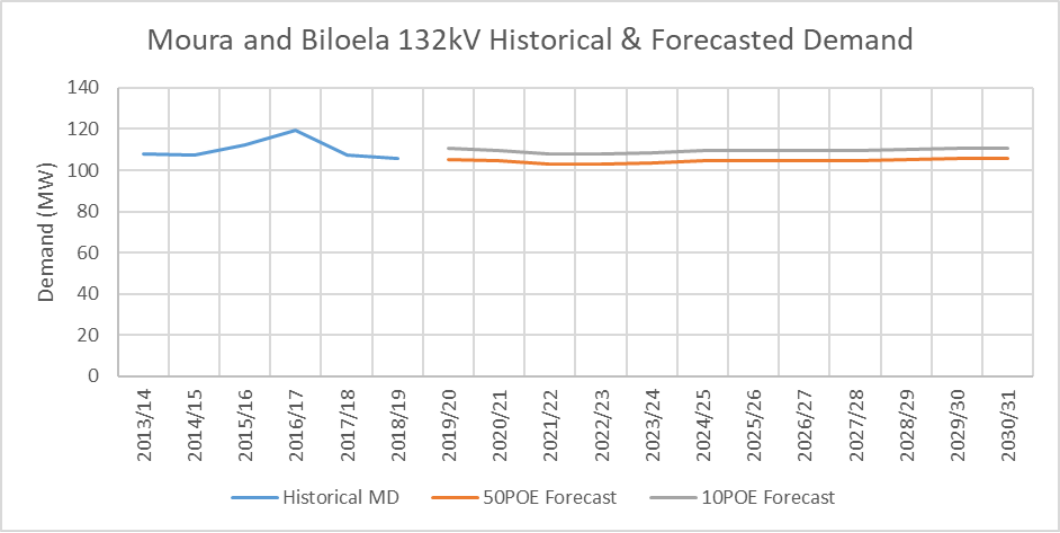


Figure 3 – Calvale 132kV Maximum Demand

The ESCO Moura Solar Farm is a committed projected connecting off Moura Substation. The plant will have a capacity of 82MW.

3. Statement of Investment Need

As outlined in the Section 2, Calvale Substation performs a vital switching function for critical grid sections, and provides connection to Central West generators and loads. Table 1 highlights the function of the network elements that are impacted by deteriorating substation asset health. The failure to replace at-risk primary plant at the substation increases the risk of Powerlink breaching its Transmission Authority Reliability Standard for Moura and Biloela.

A failure to act would also constrain the transfer of power out of the Central West zone due to the loss of network functionality, potentially impacting the dispatch of generation, scheduled network services and loads.

Table 1 – Impacted Network Elements

(Note: feeder bays 854, 855 & 8873 are not being replaced)

Switchgear Bay	Destination Substation	Function
Feeder 851	H030 Callide B	Generator Point of Connection
Feeder 852		
Feeder 853	H050 Callide PP	
Feeder 871	H040 Wurdong	CWQ-Gladstone
Feeder 8810	S002 Halys	CQ-SQ
Feeder 8811		
Feeder 8874	H029 Stanwell	Stanwell Connection
275/132kV Transformer 1	T026 Biloela and T027 Moura (plus auxiliary supplies for T030 Callide B PS)	Supply to 132kV Network
275/132kV Transformer 2		

4. Network Risk

The table below presents the historical load at risk as well as the energy at risk for loads connected to Calvale Substation at 132kV. The loss of the two Calvale 275/132kV transformers would result in the complete loss of Moura and Biloela.

Table 2 – Calvale 132kV Load at Risk

At Risk	Contingency	Metric	2014	2019
Moura and Biloela Load	Calvale 275/132kV Transformers	Max (MW)	108	106
		Average (MW)	62	65
		24h Energy Unserved Max (MWh)	1805	2066
		24h Energy Unserved Average (MWh)	1494	1563

The information shown in Table 3 are the loads at risk following a 275kV outage of feeder 871 at Calvale Substation (to Wurdong). Feeder 871 is one of the 275kV supplies to Boyne Island. In the event of an outage of feeder 871, Boyne Island is split to resecure the network.

Potline 3 is connected to the 275kV and Potlines 1 and 2 are connected to separate 132kVfeeders (7145 and 7146). As a result, each potline is at risk for a second credible contingency. The table shows the combinations and results of contingencies that impact Boyne Island for an 871 outage.

Table 3 – Calvale 275kV Feeder 871 Load at Risk

At Risk	Contingency	Metric	2014	2019
Boyne Island Potline 1	Calvale - 871 Boyne - 7146	Max (MW)	272	158
		Average (MW)	246	142
		24h Energy Unserved Max (MWh)	6466	3632
		24h Energy Unserved Average (MWh)	5914	3402
Boyne Island Potline 2	Calvale - 871 Boyne -7145	Max (MW)	305	286
		Average (MW)	276	263
		24h Energy Unserved Max (MWh)	7048	6510
		24h Energy Unserved Average (MWh)	6619	6301
Boyne Island Potline 3	Calvale - 871 Boyne - 818	Max (MW)	437	435
		Average (MW)	414	415
		24h Energy Unserved Max (MWh)	10340	10221
		24h Energy Unserved Average (MWh)	9933	9970

An outage of 275kV circuits at Calvale Substation would also have significant market Impacts; primarily the CQ-SQ and CWQ-Gladstone grid sections as well as system strength impacts on NQ generation. Table 4 below shows the extent to which the grid section capacity would be impacted for different outages concerning Calvale Substation feeders.

Table 4 – Calvale 275kV Market Impacts

At Risk	Contingency	Metric	2014	2019
CQ-SQ	Calvale - 8810 OR 8811	Max (Hrs)	11	24
		Average (Hrs)	0	13
		Max (MW)	215	1056
		Average (MW)	0	184
		24h Energy Constrained Max (MWh)	701	18865
		24h Energy Constrained Average (MWh)	10	4417
CWQ-Gladstone	Calvale - 871	Max (Hrs)	24	24
		Average (Hrs)	17	19
		Max (MW)	820	849
		Average (MW)	169	193
		24h Energy Constrained Max (MWh)	14801	11750
		24h Energy Constrained Average (MWh)	4049	4635
NQ System Strength	Calvale - 8874	Max (Hrs)	-	24
		Average (Hrs)	-	9
		Max (MW)	-	95
		Average (MW)	-	12
		24h Energy Constrained Max (MWh)	-	1385
		24h Energy Constrained Average (MWh)	-	277
H030	Feeder 851	Callide B Unit 1 (MW)	350	350
H030	Feeder 852	Callide B Unit 2 (MW)	350	350
H050	Feeder 853	Callide PP Unit 3 (MW)	450	450

5. Non Network Options

Potential non-network solutions for the 132kV network would need to provide supply to the 66kV Biloela and Moura networks. To meet the demand of the combined Biloela and Moura network, the non-network solution must be capable to delivering up to 110MW of power at peak and up to 2100MWh of energy per day (Refer Table 2). The non-network solution would be required to be capable of operating during a contingency or outage on a continuous basis until normal supply is restored.

Powerlink is not aware of any Demand Side Solutions (DSM) in the area supplied by Calvale Substation. 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.

6. Network Options

6.1 Preferred network option to meet the identified need

The recommended network solution is the replacement of all 275/132kV primary systems reaching end of life at H024 Calvale Substation by the end of 2025. This option ensures that all reliability of supply and asset condition criteria is met as well as maintaining the power transfer capability between Central West and Gladstone and South Queensland zones.

Further details of condition assessment for the Calvale Substation primary systems and their individual recommended replacement timing can be found in Reference 1.

6.2 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.

5.2.1 Do Nothing

“Do Nothing” would not be an acceptable option as the primary drivers (primary system condition) 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.

5.2.2 Supply from Blackwater Substation

Under the current configuration, Blackwater Substation is unable to supply the loads of Biloela and Moura. Reinforcing the 132kV from Blackwater Substation to support the load was assessed to be not economically feasible. Furthermore, the renewable generation in the area would likely be impacted with a material reduction in system strength due to the lack of fault level that Calvale Substation provides.

7. Recommendations

There is an investment need to maintain the functionality of the Calvale 275/132kV Substation by replacing primary systems equipment by the end of 2025 to minimise operational and compliance risks associated with the assets. In doing so, Powerlink can continue to meet its network reliability and security of supply obligations and maintain power transfer capability between Central West and Gladstone and South Queensland zones.

8. References

1. H024 Calvale Substation Electrical Condition Assessment Report 2020

2. Transmission Annual Planning Report 2020

3. Asset Planning Criteria Framework

9. Appendix A – Network Risk methodology

Feeders 8810 & 8811

These 275kV Calvale to Halys feeders 8810 and 8811 are critical to the CQ-SQ transfer capacity. The failure to keep either of these feeders in service presently reduces the CQ-SQ transfer capacity to 1100MW. Market Impacts are based on total flow through CQ-SQ cut set exceeding present limit of 1100MW.

Feeder 871

Feeder 871 is one of the three 275kV feeders forming the Gladstone cut set between Central West and Gladstone. The failure to keep feeder 871 in service would require generation to be constrained such that loss of another feeder in this cut set (811, 8859, 8875 or 812) does not overload the last remaining feeder. Market Impacts are based on total flow through Gladstone cut set exceeding thermal limit of feeder 812.

Additionally, Boyne Island load becomes vulnerable to a single contingency following the loss of feeder 871. This is represented as load at risk.

Feeder 8874

This feeder is critical to the system strength of North Queensland. If this feeder is out of service, significant renewable generators are constrained in the north. Market Impacts are based on limiting Mt Emerald WF, Haughton SF & Sun Metals SF to 50% capacity.

132kV Loads

The loads of Moura and Biloela are connected via 132kV circuits from Calvale Substation as well as from Blackwater Substation. In the event of an outage at Calvale Substation, Blackwater Substation would not be able to support Moura and Biloela loads. The loss of the 275/132kV transformers at Calvale results in the loss of supply to these Central West loads, which would exceed the 50MW limit, and the 600MWh, limit shortly after.

Generation Agreements

Powerlink is liable for any reduction in transmission capacity should the reduction be the result of any event not agreed upon with generators. The replacement of both feeders to Callide B and a single feeder to Callide PP is recommended. Should an outage occur because of failing to replace obsolete plant, Powerlink will be liable for economic losses.

Base Case Risk and Maintenance Costs Summary Report

H024 Calvale Substation Selective Replacement of Primary Plant

Version Number	Objective ID	Date	Description
1.0	A3429043	16/09/2020	Original document.
2.0	A3429043	24/09/2020	Updated maintenance costs.

1. Purpose

The purpose of this model is to quantify the base case risk cost profiles and maintenance costs for selected items of primary plant at Calvale substation which are proposed for reinvestment.

Base case risk costs and maintenance costs have been analysed over a ten-year study horizon.

2. Key Assumptions

In calculating the potential unserved energy (USE) arising from a failure of ageing primary plant at Calvale substation, the following modelling assumptions have been made:

- Historical load profiles have been used when assessing the likelihood of unserved energy under concurrent failure events;
- Due to the network and substation configuration, unserved energy generally accrues under concurrent failure events and consideration has been given to potential feeder trip events within the wider transmission network supplying the substation;
- The selected primary plant at Calvale substation supplies a mixture of industrial and mining load types. Historical load data and estimates have been used to analyse the proportion of load categories. A weighted average VCR of $56,144/MWh has been used when evaluating network risk costs; and
- The applicable VCRs published within the AER's 2019 Value of Customer Reliability Review Final Report have been used within this risk cost assessment.

3. Base Case Risk Analysis

3.1 Risk Categories

Four main categories of risk are assessed within Powerlink's risk cost approach; safety, network, financial, and environmental. Network, safety and financial risks were considered material for this project and modelled in this assessment.

3.2 Primary Systems Analysis

The following sections analyse the risk costs presented by selected primary plant at Calvale Substation.

Risk contributions are analysed based on asset type, bay and risk category.

Table 1 – Risks associated with at risk primary plant

	Mode of failure	
Equipment	**Peaceful**	**Explosive**
Circuit Breaker (CB)	Network risks (unserved energy). Safety risks to the public due to a fault that is not cleared. Financial risks to address damage caused by a fault that is not cleared and/or the failed circuit breaker.	
Current Transformer (CT)	Network risks (unserved energy). Financial risks to replace the failed equipment in an emergency manner.	Network risks (unserved energy due to loss of several adjacent bays). Safety risks primarily due to oil filled porcelain casing CTs. Financial risks associated with damage in adjacent bays and/or replacement of the failed CT.
Capacitive Voltage Transformer (CVT)	Network risks (unserved energy). Financial risks to replace the failed equipment in an emergency manner.	Network risks (unserved energy). Safety risks primarily due to oil filled porcelain casing CVTs. Financial risks associated with damage in adjacent bays and/or replacement of the failed CVT.
Structures/Foundations	Network risks (unserved energy). Safety risks (resulting from structural failure). Financial risks to replace the failed structure/foundation.	

3.2.1 Primary Plant – Risk Cost by Year

Figure 1 – Primary plant total risk cost

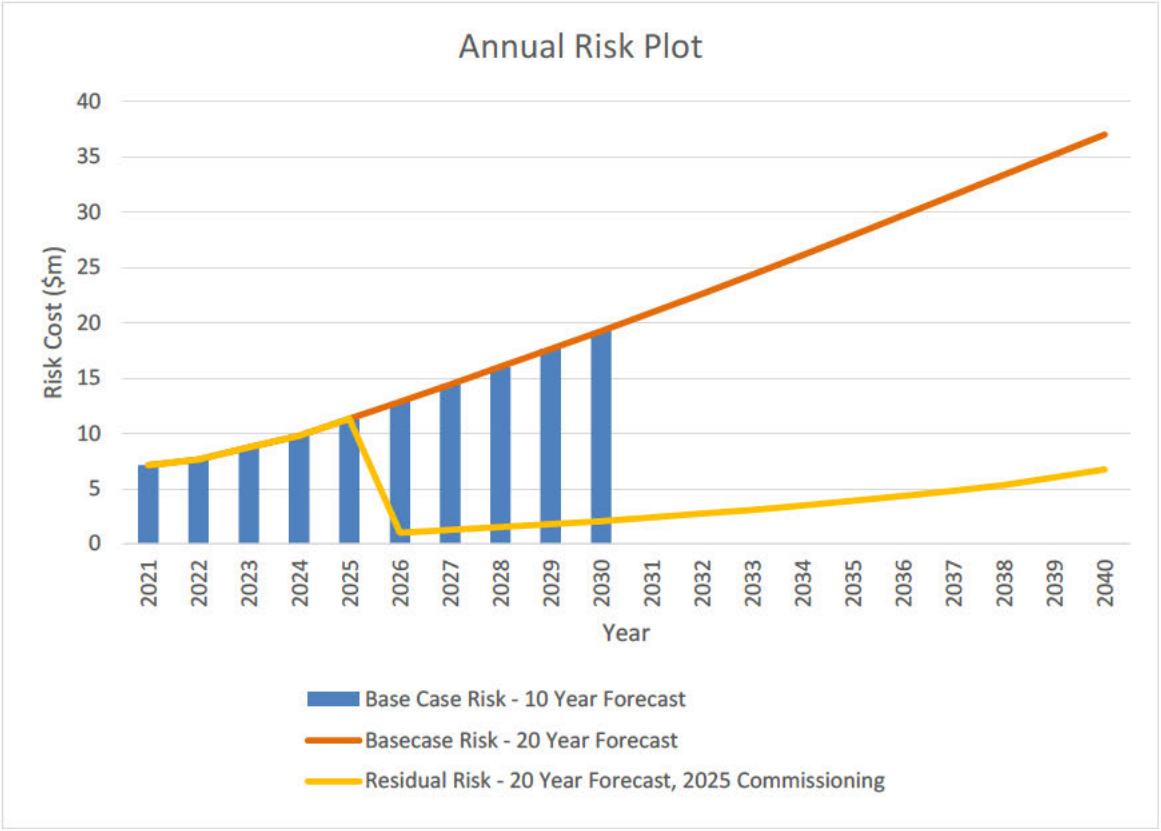


Figure 2 – Primary plant total risk cost (10 and extrapolated 20 years)

3.2.2 Primary Plant – Risk Cost Breakdown by Risk Category[1]

Figure 3 – Primary systems risk cost over time by category

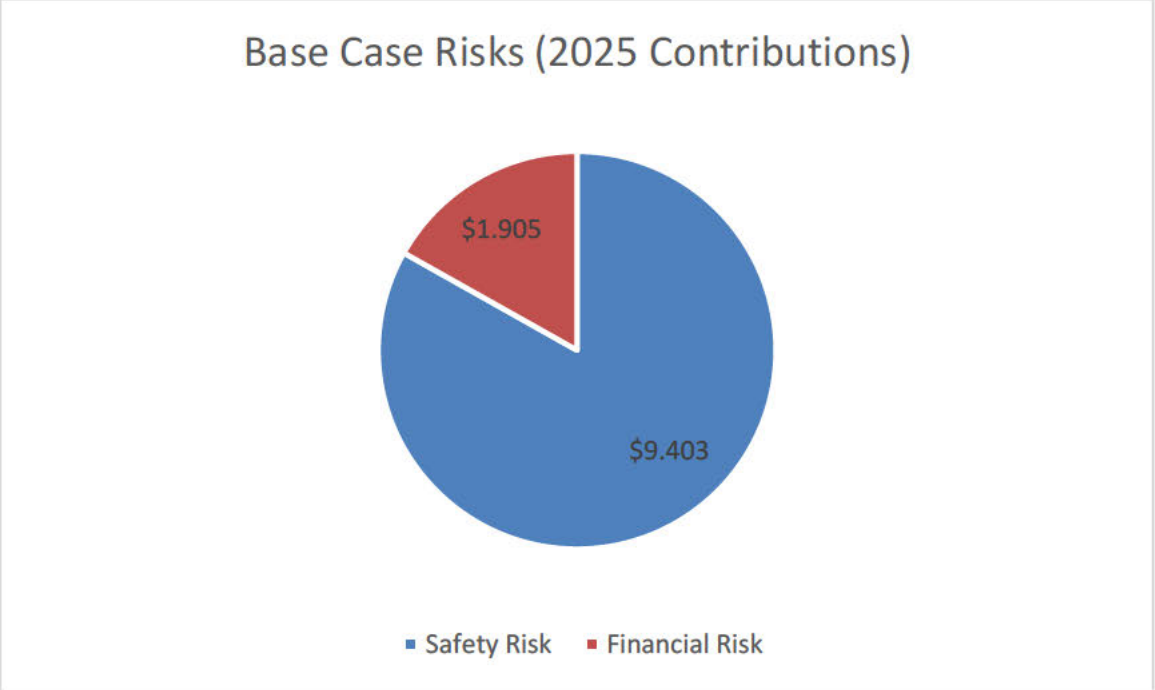


Figure 4 – Primary plant 2025 risk cost by category

[1] The network risk costs were found to be very small due to the breaker and half arrangement of Calvale 275kV substation.

3.2.3 Primary Plant – Risk Cost Breakdown by Equipment Category

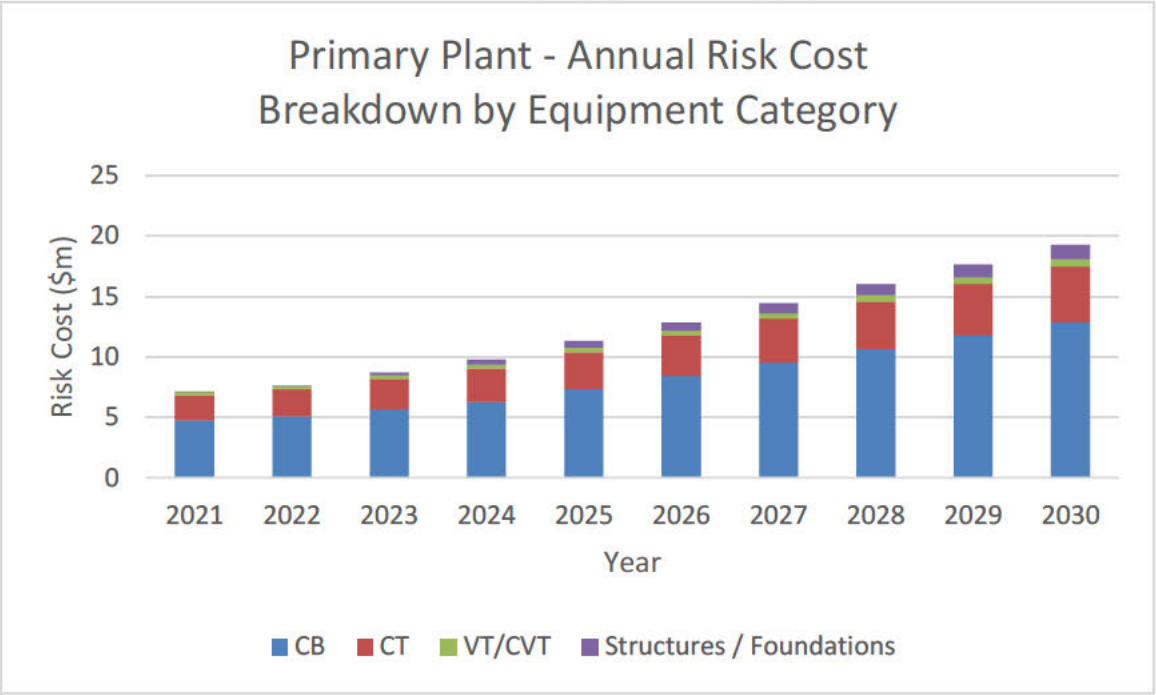


Figure 5 – Primary plant risk cost over time by equipment category

4. Maintenance costs

Two categories of maintenance costs are included in Powerlink's base case approach; routine maintenance and corrective / condition based maintenance.

The routine and corrective / condition based maintenance costs and total base case costs (maintenance plus risk) are shown in figure 6 and figure 7 below.

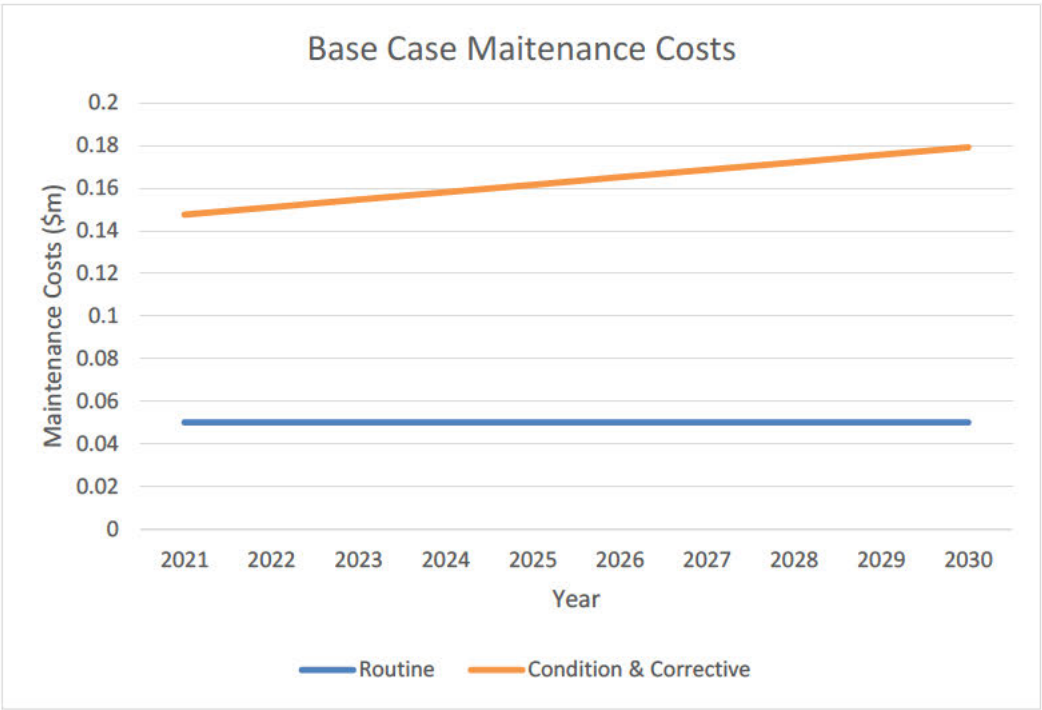


Figure 6 - Base Case Maintenance 2021 to 2030

The total base case risk and maintenance cost is show below:

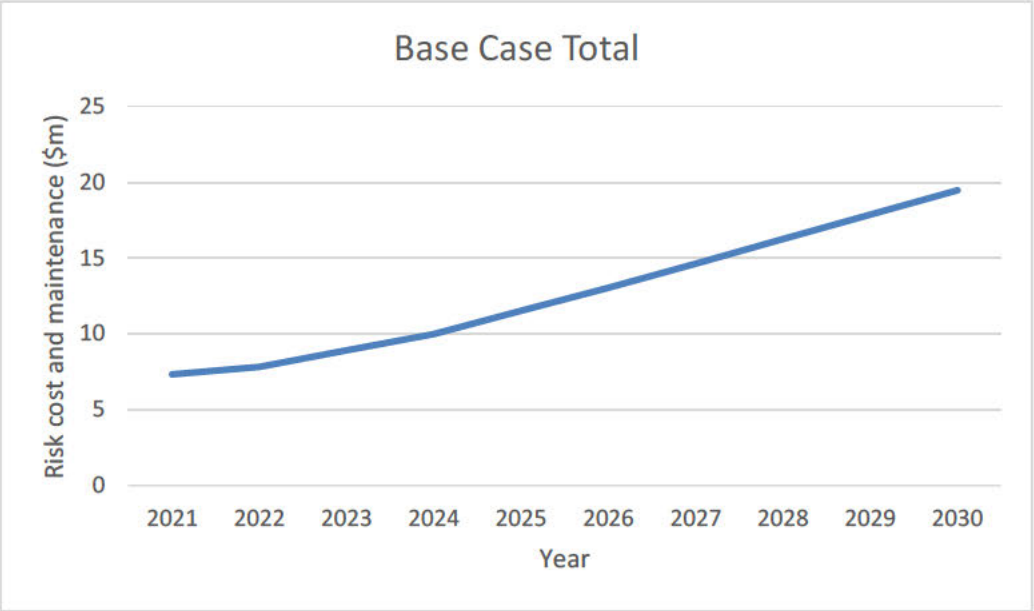


Figure 7 – Base Case Total (Risk Cost + Maintenance) 2021 to 2030

5. Participation factors

A sensitivity analysis was carried out 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).

Participation factors are defined as the ratio of percentage change in output (i.e. risk cost) to a percentage change in input (e.g. VSL). The participation factors for key model inputs are shown in the following figures.

As an example, if the estimate of VSL increases by 20%, the total risk will increase by around 65%.

Due to the breaker and half arrangement of Calvale 275kV substation, the network risk costs were found to be very small, and changes to VCR do not impact total risk cost.

The participation factors calculated below are based on an increase of input by 20%.

Table 2 – Input values, primary plant risk cost model

Probability of personnel within substation	0.4	Ratio
VSL	5	$M
Equivalent cost of serious injury	1	$M
ALARP disproportionality factor for public	10	Ratio
ALARP disproportionality factor for substation personnel	3	Ratio
Damage to external plant and equipment due to an uninterrupted fault	0.5	$M

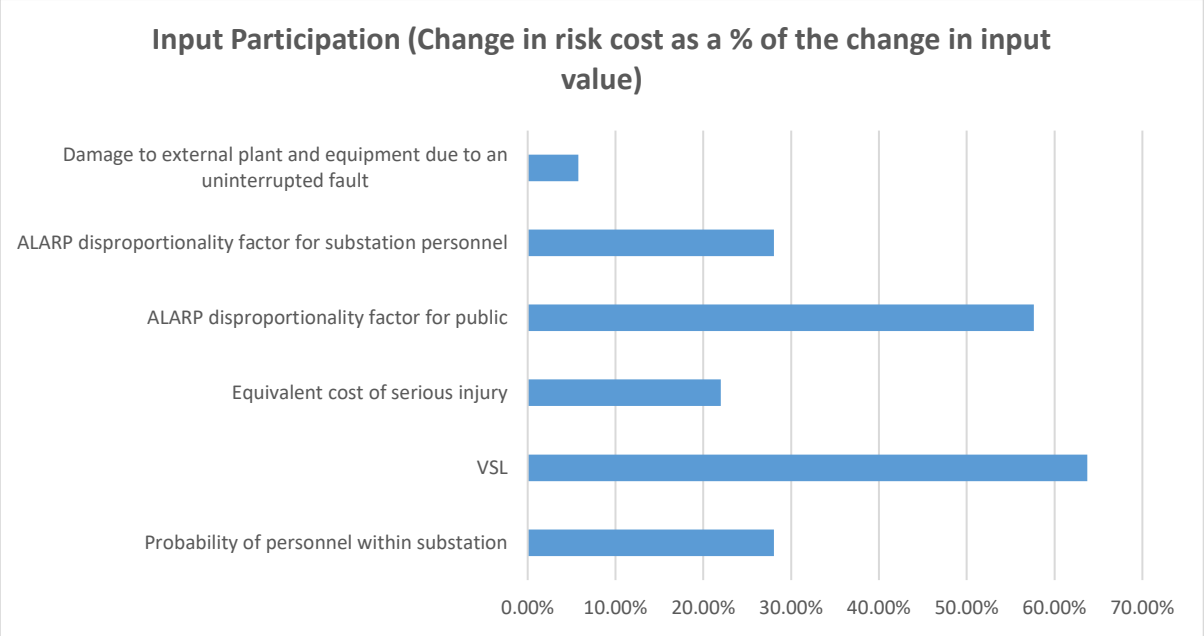


Figure 8 – Participation factors, primary plant base case risk cost model

Project Scope Report

CP.xxxxx

H024 Calvale Substation Selective Replacement of Primary Plant

Concept – Version 3

Document Control

Change Record

Issue Date	Responsible Person	Objective Document Name	Background
29 Apr 2020	[redacted]	Project Scope Report - CP.xxxxx H024 Calvale Substation Selective Replacement of Primary Plant	Ver. 3 - scope amended to include 1VT and 9VT replacement following review.
2 Apr 2020	[redacted]	Project Scope Report - CP.xxxxx H024 Calvale Substation Selective Replacement of Primary Plant	Ver. 2 - scope amended in consideration of CP.01151 works and current plant condition info.
8 Apr 2020	[redacted]	Project Scope Report - CP.xxxxx H024 Calvale Substation Selective Replacement of Primary Plant	Ver. 1 - Preliminary scope

Related Documents

Issue Date	Responsible Person	Objective Document Name
March 2020	[redacted]	H024 Calvale Substation Electrical Condition Assessment Report _2020 [A3320203]

Project Contacts

Project Sponsor	[redacted]	[redacted]
Connection & Development Manager	<name>	Ext.
Strategist - HV Asset Strategies	[redacted]	[redacted]
Planner - Main/Regional Grid	<name>	Ext.
Manager Projects	<name>	Ext.
Project Manager	<name>	Ext.
Design Coordinator	<name>	Ext.

Project Details

1. Project Need & Objective

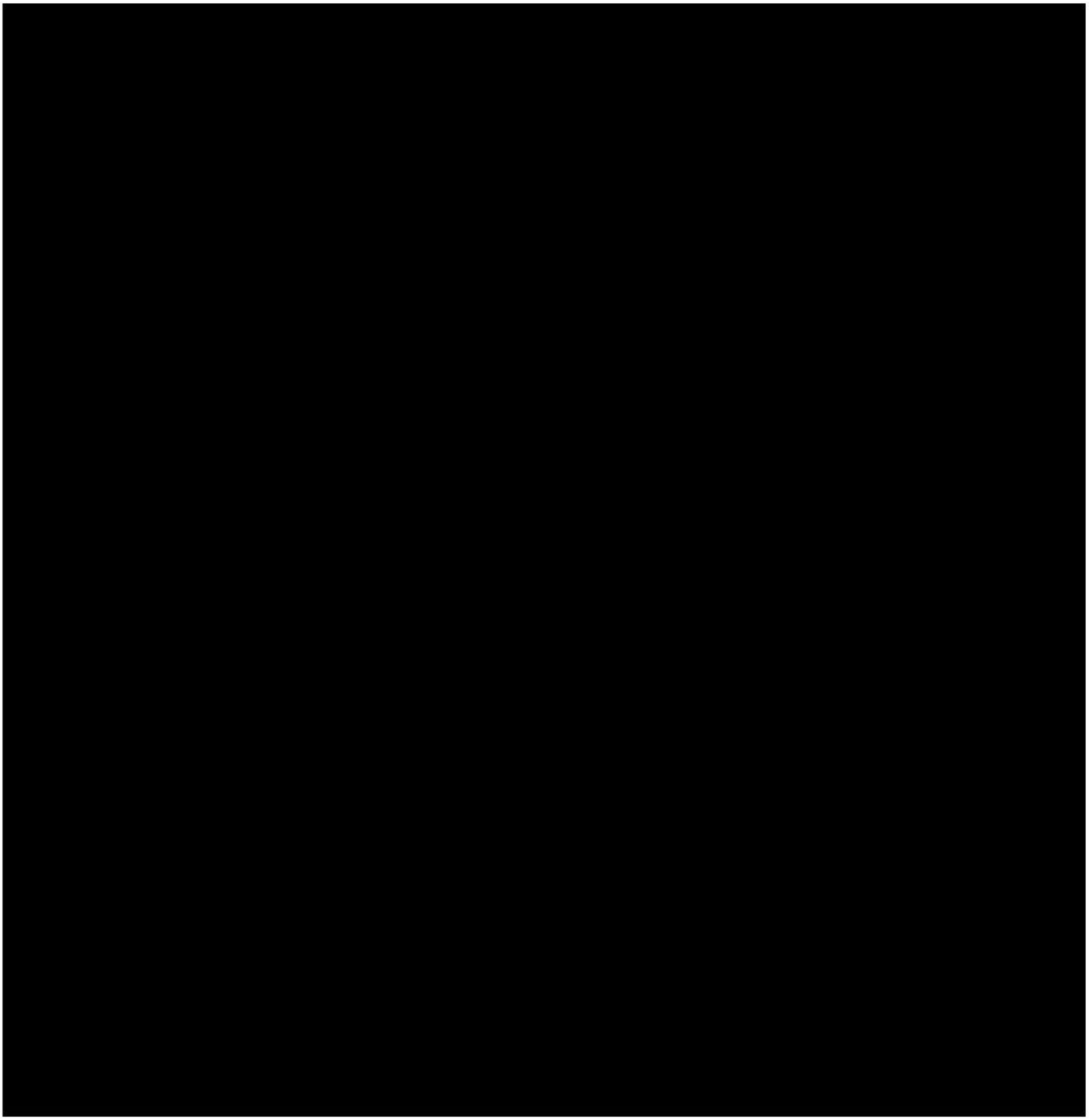
The Calvale substation was established in the mid-1980s with two 275kV generator connections for the Callide B power station and connecting feeders to Wurdong at 275kV and Callide A at 132kV. The substation was subsequently extended in 1998 for the connection of Callide C power station and the double circuit 275kV interconnector to Tarong. Further extension was undertaken in 2013 to include additional bays for the Stanwell 275kV double circuit interconnector.

A recent condition assessment of the site has identified plant condition issues with equipment items from the original installation, including unavailability of spares and lack of technical support. A high number of damaged porcelain insulators have been identified on site and there is increased risks for both safety and reliability of supply, and therefore corrective action is required.

Planning studies have determined that for Powerlink to meet planning criteria and regulatory obligations, there is an ongoing need for all connecting feeders to satisfy the transfer requirements in the Calvale area and for the 275/132kV transformation. To avoid the need for non-network support a minimum of two 250MVA transformers are required.

The objective of this project is to ensure ongoing reliability of supply from H024 Calvale substation by replacing selected primary plant from the original installation by 30 June 2025.

2. Project Drawing



3. Project Scope

3.1. 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 5 Special Considerations*.

Briefly, the project consists of replacement of selected plant items including 275kV circuit breakers and instrument transformers from the original installation.

3.1.1. Transmission Line Works

Not applicable

3.1.2. H024 Calvale - Substation Works

275/132kV Switchyard

Design, procure, construct and commission -

- the brownfield replacement of the identified primary plant including associated structures and foundations, for the following bays.

Ref.	Functional Location	Primary Plant Replacements				Asset Type
		CB	CTs	CVT	Isol/ES	Reg/Non-Reg
1	H024-C03-503	✓	✓			R
2	H024-C03-541	✓	✓	✓ (7VT)		R
3	H024-C03-8874	✓	✓			R
4	H024-C04-504	✓	✓			R
5	H024-C04-542	✓	✓	✓ (8VT)		R
6	H024-C04-851	✓	✓			R
7	H024-C05-505	✓	✓			R
8	H024-C05-852	✓	✓			R
9	H024-C05-871	✓	✓	✓ (4VT)		R
10	H024-C06-506	✓				R
[redacted]						
12	H024-C06-8810	✓				R
13	H024-C06-8810-1	✓				R
14	H024-C07-507					R
[redacted]						
16	H024-C07-8811					R
17	H024-C07-8811-1	✓				R
18	H024-KC1-1BUS			✓ (1VT)		R
19	H024-KC2-2BUS					R
20	H024-D04-442			✓ (9VT)		R

Table 1 – H024 Calvale selected primary plant replacements

- modify secondary systems accordingly, including remote ends as required;
- upgrade metering to current Powerlink standard as required;
- confirm, or otherwise, presence of asbestos containing materials and PCB oil contamination and dispose of affected materials accordingly;
- decommission all redundant plant and equipment, recover and dispose of accordingly; and
- update drawing records, SAP, config files, etc. accordingly.

Auxiliary Supply Works

Design, procure, construct and commission -

- establish a new station transformer connected to 1T transformer tertiary to replace the 6.6/0.433kV 300kVA 4T station transformer, the scope includes all necessary civil works and integration with site oil containment system;
- integrate replacement station transformer with existing local AC supply arrangements including modifications to existing AC changeover board as required;
- modify secondary systems accordingly, noting other parties will have responsibility for any consequential remote end works;
- decommissioning of 4T transformer, including recovery and disposal of redundant transformer, related HV and LV cables and equipment; and
- update drawing records, SAP, config files, etc. accordingly.

3.1.3. Telecoms Works

Not applicable

3.1.4. Easement/Land Acquisition & Permits Works

Not applicable

3.2. Key Scope Assumptions

The following assumptions should be included in the estimating of this scope:

- The timing for the future retirement of Callide B PS 1 and 2 generators is uncertain and therefore the estimate should include the costs of replacement for the identified primary plant (refer Table 1) in the associated connection bays - diameters C04 & C05. The project scope may subsequently be amended dependent upon the future timing of the generator retirements.
- It should be assumed the 6.6kV transformer bushings are the connection point for the CS Energy interface at 4T station transformer.

4. Project Timing

4.1. Project Approval Date

The anticipated date by which the project will be approved is 31 December 2022.

4.2. Site Access Date

H024 Calvale is an established substation on Powerlink owned land and site access is available.

4.3. Commissioning Date

The latest date for the commissioning of the new assets included in this scope and the decommissioning and removal of redundant assets, where applicable, is 30 June 2025.

5. Special Considerations

- The project scope includes works on regulated and non-regulated assets. The estimate is to identify separate costs for the regulated assets and non-regulated assets;
- The project is likely to trigger minor secondary systems works at remote end sites, including H030 Callide B PS and H050 Callide PP.
- Powerlink and CS Energy are parties to a Connection and Access Agreement (CAA) for Callide B PS and agree to take a cooperative approach and consult on any installation activity impacting the other Party's equipment.
- Powerlink and Callide PP Owners are parties to a CAA for Callide PP and agree to take a cooperative approach, and consult on any installation activity impacting the other party's equipment.

6. Asset Management Requirements

Equipment shall be in accordance with Powerlink equipment strategies.

Unless otherwise advised [redacted] will be the Project Sponsor for this project. The Project Sponsor must be included in any discussions with any other areas of Strategy and Business Development.

[redacted] will provide the primary customer interface with CS Energy. The Project Sponsor should be kept informed of any discussions with the customer.

7. Asset Ownership

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

H024 Calvale station supply includes a 6.6kV connection interface between Powerlink and CS Energy. The ownership and interface boundaries that apply are described in the associated CAA.

8. 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.

9. Options

Not applicable

10. Division of Responsibilities

A division of responsibilities document will be required to cover any changes impacting interface boundaries with CS Energy for Callide B PS and the owners for Callide PP for Callide C PS. The Project Manager will be required to draft the document and consult with the Project Sponsor to arrange sign-off between Powerlink and the relevant customer.

11. Related Projects

Not applicable

Concept Estimate for CP.xxxxx - H024 Calvale Substation Selective Replacement of Primary Plant

Record ID	A3348057	
Policy stream	Asset Management	
Authored by	[redacted]	Snr Project Manager
Reviewed by	[redacted]	Team Leader Projects – Team 3
Approved by	[redacted]	Manager Projects – Team 3

Table of Contents

1. Executive Summary

The Calvale Substation was established in the mid-1980s with two 275kV generator connections for the Callide B power station and connecting feeders to Wurdong at 275kV and Callide A at 132kV. The substation was subsequently extended in 1998 for the connection of Callide C power station and the double circuit 275kV interconnector to Tarong. Further extension was undertaken in 2013 to include additional bays for the Stanwell 275kV double circuit interconnector.

A recent condition assessment of the site has identified plant condition issues with equipment items from the original installation, including unavailability of spares and lack of technical support. There is increased risks for both safety and reliability of supply, and therefore corrective action is required.

Planning studies have determined that for Powerlink to meet planning criteria and regulatory obligations, there is an ongoing need for all connecting feeders to satisfy the transfer requirements in the Calvale area and for the 275/132kV transformation.

The objective of this project is to ensure ongoing reliability of supply from H024 Calvale Substation by replacing selected primary plant from the original installation by 30 June 2025. However, final completion has been delayed slightly to align with the customer's scheduled generator outages.

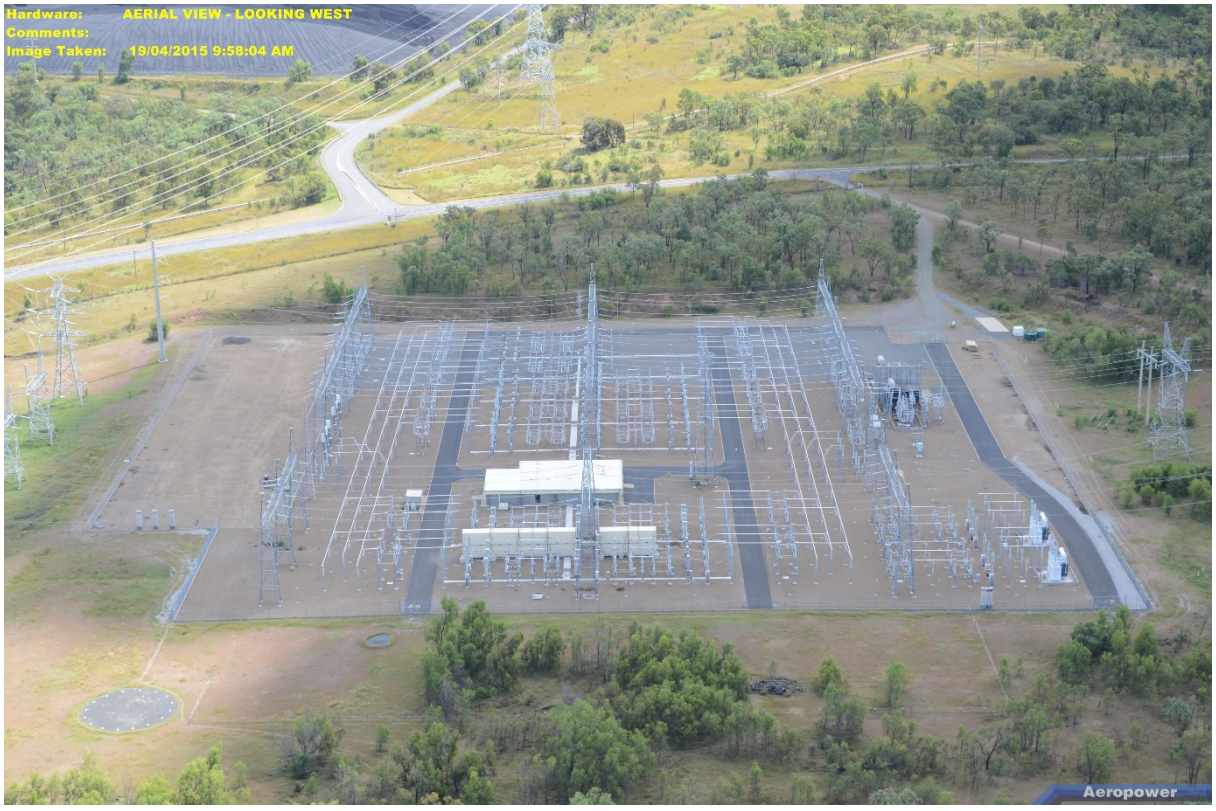


Figure 1 – Aerial Photo of H024 Calvale Substation – 2015

1.1 Project Estimate

Estimate Components		Base $	Escalated $
Estimate Class	5		
Estimate Accuracy	+100% / -50%		
Base Estimate		**12,664,417**	**15,065,837**
Mitigated Risk	[redacted]	[redacted]	[redacted]
Contingency Allowance	[redacted]	[redacted]	[redacted]
TOTAL		[redacted]	[redacted]

1.2 Project Financial Year Cash Flows

	June 2020 Base $	Escalated $
To June 2020	1,668	1,668
To June 2021	26,467	27,553
To June 2022	26,467	28,682
To June 2023	3,084,777	3,479,973
To June 2024	4,852,267	5,698,330
To June 2025	2,336,385	2,856,262
To June 2026	2,336,385	2,973,369
TOTAL	**12,664,417**	**15,065,838**

2. Project and Site Specific Information

2.1 Project Dependencies & Interactions

This project is dependent on the completion delivery of the following projects:

Project No.	Project Description	Planned Commissioning Date	Comment
Dependencies			
Nil			
Interactions			
CP.01151	Calvale and Callide B SSR	30 June 2023	Expected Completion Date subject to Generator Outages. Potential overlap in project schedules.
CP.01151	Calvale and Callide B SSR	30 June 2023	Expected Completion Date subject to Generator Outages. Potential overlap in project schedules.
Other Related Projects			
CP.01546	Callide A – Calvale 132kV Network Re-Investment	25 June 2021	Expected Completion Date subject to MSP Resources.
CP.02725	Metering Replacement	24 June 2020	New IP Metering Standard established.

2.2 Site Specific Issues

H024 Calvale is an established substation on Powerlink owned land and site access is available.

3. Selective Replacement of Primary Plant at H024 Calvale Substation

3.1 Definition

3.1.1 Scope

Briefly, the project consists of replacement of selected plant items including 275kV circuit breakers and instrument transformers from the original installation.

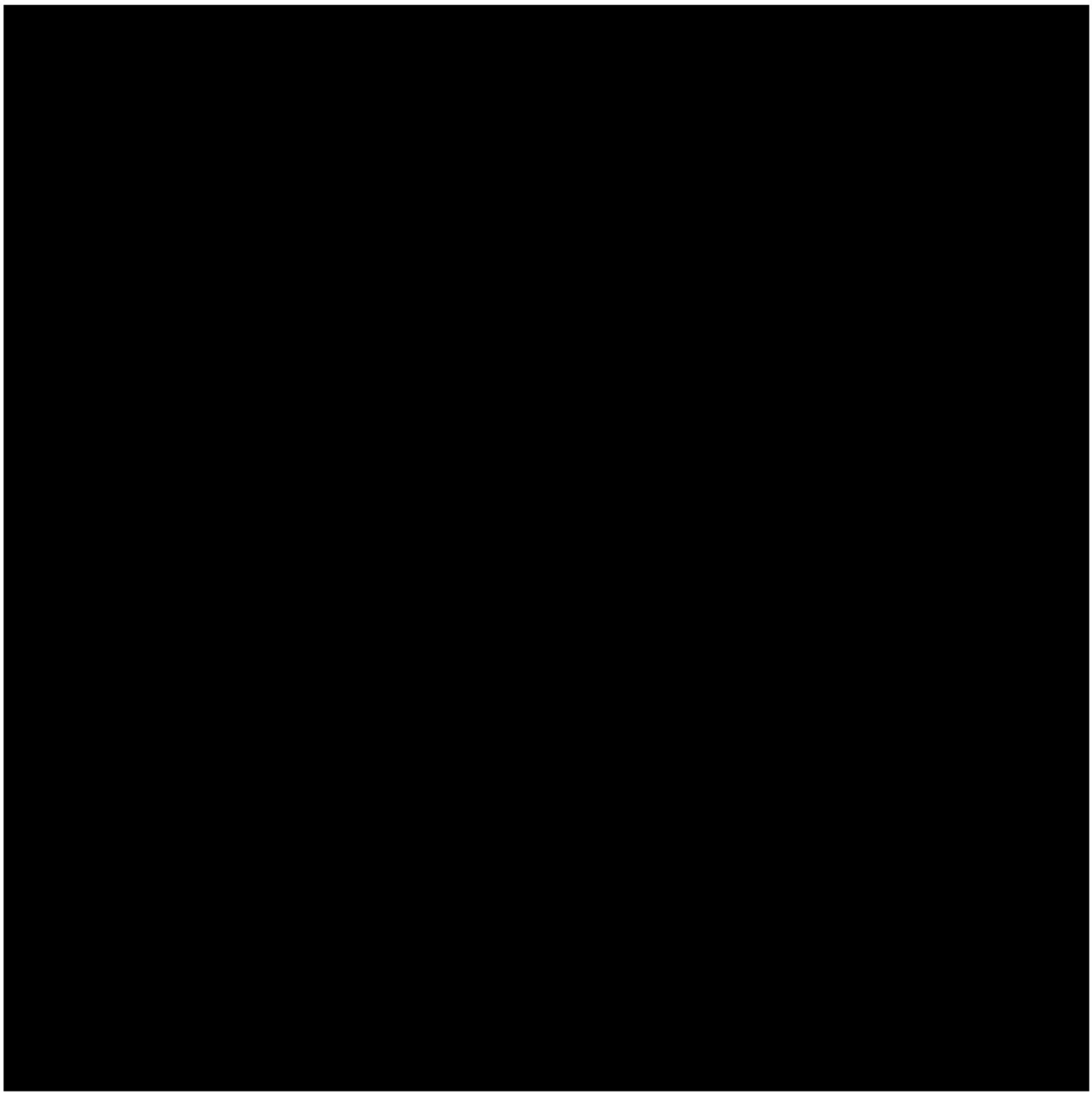


Figure 2

3.1.1.1 Substations Works

Design, procure, construct and commission -

- The brownfield replacement of the identified primary plant including associated structures and foundations, for the following bays -

Ref.	Functional Location	Primary Plant Replacements				Asset Type
		CB	CTs	CVT	Isol/ES	Reg/Non-Reg
1	H024-C03-503	✓	✓			R
2	H024-C03-541	✓	✓	✓ (7VT)		R
3	H024-C03-8874	✓	✓			R
4	H024-C04-504	✓	✓			R
5	H024-C04-542	✓	✓	✓ (8VT)		R
6	H024-C04-851	✓	✓			R
7	H024-C05-505	✓	✓			R
8	H024-C05-852	✓	✓			R
9	H024-C05-871	✓	✓	✓ (4VT)		R
10	H024-C06-506	✓				R
12	H024-C06-8810	✓				R
13	H024-C06-8810-1	✓				R
14	H024-C07-507					R
16	H024-C07-8811					R
17	H024-C07-8811-1	✓				R
18	H024-KC1-1BUS			✓ (1VT)		R
19	H024-KC2-2BUS					R
20	H024-D04-442			✓ (9VT)		R

Table 1 – H024 Calvale selected primary plant replacements

Other relevant scope activities include:

- modify secondary systems accordingly, including remote ends as required;
- upgrade metering to Powerlink IP Metering standard as required;
- confirm, or otherwise, presence of asbestos containing materials and PCB oil contamination and dispose of affected materials accordingly;
- decommission all redundant plant and equipment, recover and dispose of accordingly; and
- update drawing records, SAP, configuration files, etc. accordingly.

3.1.1.2 Auxiliary Supply Works

Design, procure, construct and commission -

- establish a new station transformer connected to 1T transformer tertiary to replace the 6.6/0.433kV 300kVA 4T station transformer, the scope includes all necessary civil works and integration with site oil containment system;
- integrate replacement station transformer with existing local AC supply arrangements including modifications to existing AC change over board as required;
- modify secondary systems accordingly, noting other parties will have responsibility for any consequential remote end works;
- decommissioning of 4T transformer, including recovery and disposal of redundant transformer, related HV and LV cables and equipment; and
- update drawing records, SAP, config files, etc. accordingly.

3.1.1.3 Transmission Line Works

Not applicable

3.1.1.4 Telecommunication Works

Not applicable

3.1.1.5 Easement/Land Acquisition & Permit Works

Not applicable

3.1.2 Major Scope Assumptions

- The project is likely to trigger minor secondary systems works at remote end sites, including H030 Callide B PS and H050 Callide PP. The cost and associated design, installation and commissioning works for remote end sites including H030 Callide B PS and H050 Callide PP Owners will be covered by CS Energy and/or Callide PP. This includes all switching, isolations, testing and commissioning to be covered by CS Energy and/or Callide PP Owners.
- Outages at H024 Calvale Substation, H030 Callide B Power Station and H050 Callide C Power Station including remote end substations will be available to support the project schedule with a final commissioning date.
- Any new protection or metering panels will be installed in the existing brick control building in two different stages due to space limitations.
- It is assumed the existing cable trenches within the Calvale Substation shall have sufficient capacity to support the new cable requirements for this project.
- It is assumed all conduits are in place from existing cable trenches to existing plant and have sufficient capacity for the new cable installation within the Calvale Substation for this project.

3.1.3 Scope Exclusions

- The cost and associated design, installation and commissioning works to replace Feeder 851 Protection Relays and Feeder 852 Protection Relays at H030 Callide B Power Station.
- The cost and associated design, installation and commissioning works to replace Feeder 853 protection relays and Feeder 854 protection relays at H050 Callide C Power Station.
- The scope of works for this project excludes the existing primary and secondary systems equipment for all 275kV bays in diameters =C01 and =C02 at H024 Calvale Substation.
- Replacement of the 50V DC battery systems at H024 Calvale Substation are excluded from this project.

3.2 Project Execution

3.2.1 Project Schedule

The following milestones are required by the project team to deliver the project:

Task	Target Completion
Project Approval Notice (issue of PAN)	31 Dec 2022
Design Commencement	Jan 2023
Design Complete	Jun 2023
Procurement Orders	Mar 2023
Procurement Deliveries	Jan 2024
Contract Award	Jan 2024
Site Access Date	Feb 2023
Construction and Commissioning Stages [aligned with annual Generator outage/s]	Feb 2023 - Nov 2023
Construction and Commissioning Stages [aligned with annual Generator outage/s]	Feb 2024 - Nov 2024
Construction and Commissioning Stages [aligned with annual Generator outage/s]	Feb 2025 - Nov 2025
Construction and Commissioning Stages [aligned with annual Generator outage/s]	Feb 2025 - Jun 2026
Project Completion	**30 June 2026**
Target Completion Date	**30 June 2026**

Table 2 – Proposed Project Milestones

3.2.2 Network Impacts

- The timing for the future retirement of Callide B PS 1 and 2 generators is unknown.
- Planning studies have determined that for Powerlink to meet planning criteria and regulatory obligations, there is an ongoing need for all connecting feeders to satisfy the transfer requirements in the Calvale area and for the 275/132kV transformation.

3.2.3 Project Staging

A Project Staging Plan and Project Outage Plan will be developed in the Project Definition Stage. It is anticipated recovery of assets and cabling will be performed at each construction and commissioning stage.

3.2.4 Resourcing

- Design will be performed by Powerlink.
- An invitation to tender (ITT) will be issued to the current Contractor for construction works at H024 Calvale Substation.
- The Maintenance Service Provider (MSP) will carry out all Factory Acceptance Testing (FAT) and Site Acceptance Testing (SAT) as required.
- MSP shall carry out all switching, isolations, construction interfaces to in-service plant, panels, cubicles and kiosk's including commissioning works at H024 Calvale, T238 Callide A, S002 Halys, H029 Stanwell and H040 Wurdong Substations as required.

3.3 Project Estimate

Estimate Components		Base $	Escalated $
Estimate Class	5		
Estimate Accuracy	+100% / -50%		
Base Estimate		**12,664,417**	**15,065,837**
Mitigated Risk	[redacted]	[redacted]	[redacted]
Contingency Allowance	[redacted]	[redacted]	[redacted]
TOTAL		[redacted]	[redacted]

3.4 Project Financial Year Cash Flows

	June 2020 Base $	Escalated $
To June 2020	1,668	1,668
To June 2021	26,467	27,553
To June 2022	26,467	28,682
To June 2023	3,084,777	3,479,973
To June 2024	4,852,267	5,698,330
To June 2025	2,336,385	2,856,262
To June 2026	2,336,385	2,973,369
TOTAL	**12,664,417**	**15,065,838**

3.5 Project Asset Classification

Asset Class	Asset Life	Base $	Percentage
Secondary systems	15 years	2,772,829	22%
Communications	15 years		
Primary plant	40 years	9,891,587	78%
Transmission lines	50 years		
TOTAL		**12,664,417**	

4. References

Document name	Version	Date
Project Scope Report	3.0	08/04/2020