January 2026

Powerlink 2027-32 Revenue Proposal

Project Pack

CP.03208 Mudgeeraba Selective Primary Plant Replacement

Project Status: Unapproved

Network Requirement

The Mudgeeraba 275/110kV Substation was first developed in 1971 as a 110kV bulk supply point for the southern Gold Coast and Tweed Valley. The 275kV supply from Swanbank was established through transformer ended feeders in 1974 and 1976. Subsequent 110kV developments occurred in the early 1980's, early 1990's and mid-2000's. A 275kV bus arrangement was established in 2001. Due to increasing fault levels much of the original 110kV equipment has been progressively replaced over the last 20 years. There is now a mix of equipment from the 1970's through to the 2000's.

The primary plant from the original substation construction is now over 50 years old while plant installed up to the early 1990's will be approaching 40 years old by the end of this decade. This requires selective replacement to manage the risk associated with the equipment failing in service or during maintenance switching operations. A number of instrument transformers are oil filled and in porcelain housing and due to their age, now have an increased probability of explosive failures with catastrophic safety consequences. The older circuit breakers are also approaching end of life and maintenance records show a variety of issues such as SF6 leaks and compressor failures in the air systems [1].

Powerlink's 2025 Central scenario load forecasts confirm an enduring need for an ongoing supply of bulk electricity to the Gold Coast area. In addition, there is an enduring need for 110kV supply to Terranora to supply the Tweed Valley and support inter-regional power transfers through the Directlink Interconnector.

The removal or reconfiguration of the Mudgeeraba 275/110kV Substation would violate Powerlink's N-1-50MW/600MWh Transmission Authority reliability standard and significantly impact power transfers across the Directlink Interconnector [2].

Recommended Option

As this project is currently 'Unapproved', project need and options will be subjected to the public RIT-T consultation process to identify the preferred option closer to the time of investment. The objective is to address the asset condition issues identified with the originally installed primary plant.

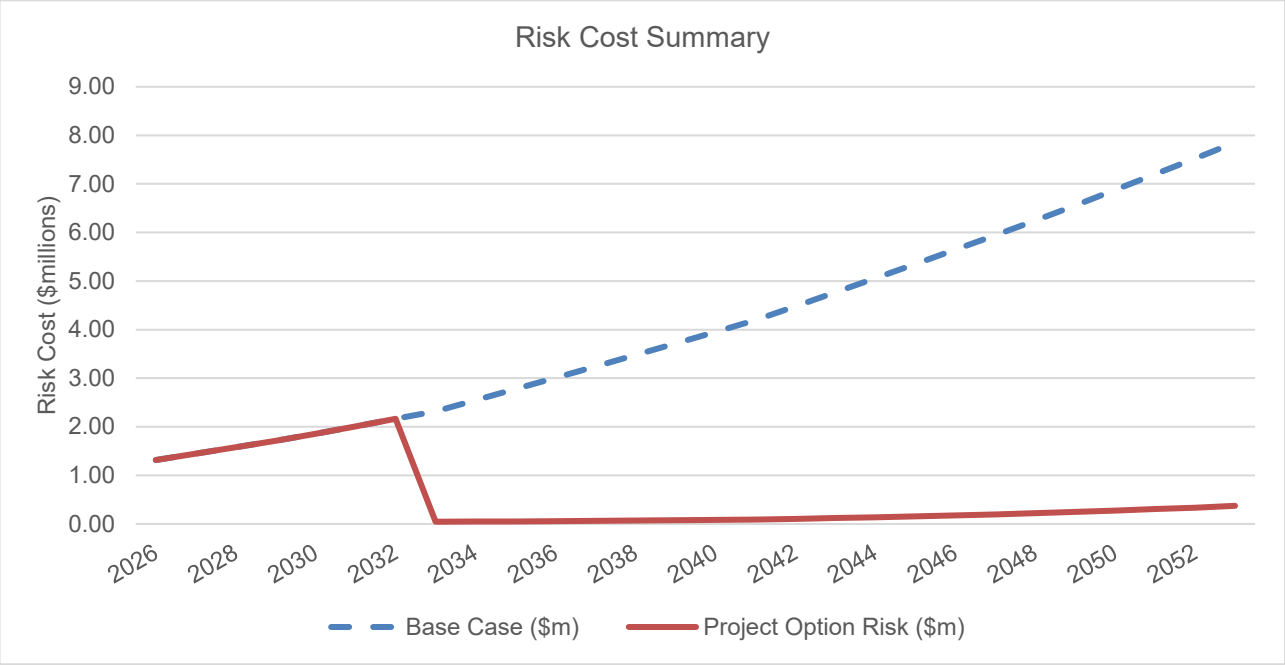
The current recommended option involves the replacement of selected 275kV and 110kV primary plant by June 2032 [3].

Options considered but not proposed include:

- Do Nothing – rejected due to non-compliance with reliability obligations;
- Decommission ageing primary plant assets – rejected due to non-compliance with reliability obligations;
- Full primary plant replacement – expected to be greater overall cost; and
- Non-network option – no viable non-network options have been identified at this time.

Figure 1 shows the current recommended option reduces the forecast risk monetisation profile of the Mudgeeraba Substation primary plant from around $2.15 million per annum in 2032 to less than $0.05 million from 2033 [5].

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



Cost and Timing

The estimated cost to replace selected 275kV primary plant is $27.2 million ($2025/26) [4].

Target Commissioning Date: June 2032.

Documents in CP.03208 Project Pack

Public Documents

1. H004 Mudgeeraba Substation Condition Assessment Report
2. CP.03208 Mudgeeraba Selective Primary Plant Replacement – Planning Statement
3. CP.03208 Mudgeeraba Selective Primary Plant Replacement – Project Scope Report
4. CP.03208 Mudgeeraba Selective Primary Plant Replacement – Concept Estimate
5. CP.03208 Mudgeeraba Selective Primary Plant Replacement – Risk Cost Summary Report

SITE CONDITION ASSESSMENT REPORT

H004 MUDGEERABA

Report requested by:	[redacted]	**Request Date:**	09/04/2025
Report Prepared by:	[redacted]	**Date of site visit:**	28/03/2025
AUTHOR/S:	[redacted]		
Report Reviewed by:	[redacted]	**Review Date:**	20/07/2025
Issue Approved by:	[redacted]	**Issue Date:**	15/11/2025

Date	Version	Objective ID	Nature of Change	Author	Authorisation
		A1612916	Supplementary Condition Assessment Report	[redacted]	[redacted]
22/07/2014	2.0	A2003046			
20/07/2025	**3.0**	**A5932345**	**Revision Update**	[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 from site visit date stated above.

Contents

EXECUTIVE SUMMARY

This supplementary report provides an overview of the primary plant condition at H004 Mudgeeraba. The report is intended to assist with determining the future strategies for substation refurbishment or rebuilding.

The assessment has been formulated based on a site inspection, with the assistance from data extracted from SAP including notifications and work orders, dissolved gas analysis (DGA), equipment age information, and previous condition assessment reports. The findings from this site condition assessment have been used to update part of the summary of substation scores, originally from the 2014 site condition assessment report.

Photographs of items of major concern are included in the text and all photographs taken during the site visit have been retained for future reference.

The summary of recommendations is contained in Table 25 resented in Section 3 of this report.

Substation constraints

The fault level on the 275kV system at the time of this report is 9.62kA which is below the lowest rated equipment (31.5kA). The fault level on the 110kV system is presently 21.45kA which is below the lowest rated equipment (25 kA) and lowest rated earth tails (24kA@ 310ms).

Land is available within the existing site for some expansion, but adjacent residential and commercial developments may limit the amount of expansion able to be achieved, especially as Powerlink land has a large amount of native vegetation.

At time of the CA, a restricted access zone for [redacted] was present and as such the access to areas of the 275kV yard was restricted. As such, not all equipment here could be inspected on site.

1. INTRODUCTION

1.1 Report Scope

This condition assessment report is an update to the previously produced condition assessment reports (Objective Ids A2003046, A1612916, A1404167, A1025374 & A1538508). The scope of this report is expanded from the last condition assessment to include high voltage equipment in both 110 kV and 275 kV switchyards. Remaining capacitor banks (No. 2 and No. 4), and power transformers (No. 1, No. 4, and No. 5) are excluded from this report. There is a separate condition assessment report for transformer no.1. In addition, the following bays are excluded from this report: D04-794, D11-444, D19-445, D15-754, D18-755, D19-445, D20-758, D21-757 and D22-7839 as these are all bays with equipment that have low health indices indicating satisfactory condition.

1.2 System information

Mudgeeraba substation was initially developed as the 110kV bulk supply point for the southern section of the Gold Coast and for the Northern New South Wales area. Together with Molendinar substation, Mudgeeraba substation provides supply to the Energy Queensland distribution network on the Gold Coast. Mudgeeraba is located at the southern end of this region and also supplies 110kV to Essential Energy's Terranora substation in northern New South Wales. In addition, there is a HVDC Direct Link between QLD and NSW.
Initial development in 1971 at Mudgeeraba was for 6 X 110kV bays associated with Beenleigh (1), Burleigh (2), and Terranora (2) feeders enforced with a single bus coupler. Subsequent development included the first 275/110kV transformer and associated 110kV bay in 1974 and a second transformer and 110kV bay in 1976.

Further development has occurred as follows; feeder bays 779, 780,794 (1981) and Varsity Lakes (2001), 2 capacitor bank bays (1994), third 275/110 kV transformer bay and bus section bay (1991), 4 transformer 110/33kV and associated 110 kV bay (2007).

The Mudgeeraba Substation is supplied from S003 Greenbank Substation by two 275kV single circuit transmission lines (F835 and F836). Initially these lines originated from Swanbank and were configured as transformer ended feeders through to 275kV circuit breakers. A 275kV fully switchable bus arrangement at Mudgeeraba Substation was established in 2001 with three 275/110kV power transformers of which one was decommissioned and removed.

Figure 2- Aerial Photograph of H004 Mudgeeraba Substation

[redacted]

Figure 2-H004 Mudgeeraba General Arrangement –Drg No H-112284-001

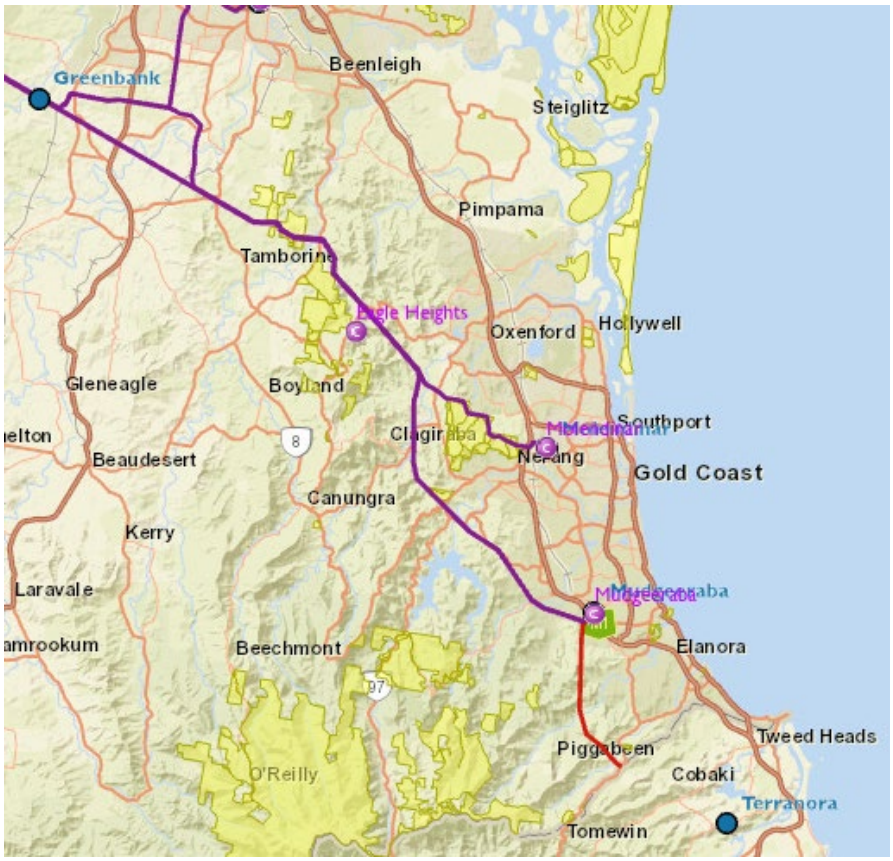


Figure 4--Overview of Mudgeeraba HV Supply & Connectivity Network

Figure 5- Mudgeeraba Restricted Access Zone 28/03/2025

1.3 Ratings

Fault levels calculated as of March 2025 are:

- 275 kV – 9.62 kA
- 110 kV – 21.45 kA
- 33 kV – 10.73 kA
- 19.1 kV – 15.66 kA

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

Table 1- Mudgeeraba Bay Ratings

Functional Location	Description	Start-up date	Bay Continuous Rating	Fault Current Rating	Fault Current Period	Comment On Rating
H004-C01-501-	275kV 1 COUPLER BAY	29/07/2001	2,500 A	31.50 kA	1.0 s	Ok
H004-C01-541-	275kV 1 TRANSFORMER BAY	1/07/1991	2,500 A	31.50 kA	1.0 s	Ok
H004-C02-502-	275kV 2 COUPLER BAY	10/05/1992	2,500 A	31.50 kA	1.0 s	Ok
H004-C02-597-	275kV SPARE 7	1/07/1991				Ok
H004-C02-835-	835 FEEDER BAY	1/07/1991	2,500 A	31.50 kA	1.0 s	Ok
H004-C03-503-	275kV 3 COUPLER BAY	24/04/1992	2,500 A	31.50 kA	1.0 s	Ok
H004-C03-545-	275kV 5 TRANSF BAY	1/07/1991	1,200 A	31.50 kA	1.0 s	Not as per Standard Rating
H004-C03-836-	836 FEEDER BAY	1/07/1991	2,500 A	31.50 kA	1.0 s	Ok
H004-C51-584-	275kV 4 CAPACITOR BAY	20/12/2002	1,250 A	40.00 kA	1.0 s	Not as per Standard Rating
H004-D04-794-	794 FEEDER BAY	5/05/2007	1,000 A	40.00 kA	1.0 s	Not as per Standard Rating
H004-D05-706-	706 NERANG 110KV BAY	1/07/1981	1,000 A	25.00 kA	1.0 s	Not as per Standard Rating
H004-D06-482-	110kV 2 CAPACITOR BAY	1/07/1994	1,066 A	25.00 kA	1.0 s	Not as per Standard Rating
H004-D07-779-	779 FEEDER BAY	1/07/1981	1,000 A	25.00 kA	1.0 s	Not as per Standard Rating
H004-D08-780-	780 FEEDER BAY	1/07/1981	1,000 A	25.00 kA	1.0 s	Not as per Standard Rating

H004-D09-491-	SPARE 1 BAY	1/07/1972	1,600 A	25.00 kA	-	Not as per Standard Rating
H004-D10-441-	110kV 1 TRANSF BAY	1/07/1991	1,600 A	31.50 kA	1.0 s	ok
H004-D11-444-	4 TRANSFORMER 110KV BAY	15/11/2007	1,275 A	40.00 kA	1.0 s	Not as per Standard Rating
H004-D13-411-	110kV 1-3 BUS SECTION BAY	1/07/1991	1,600 A	26.30 kA	3.0 s	Not as per Standard Rating
H004-D13-412-	110kV 2-4 BUS SECTION BAY	1/07/1991	1,600 A	26.30 kA	3.0 s	Not as per Standard Rating
H004-D14-443-	110KV 3 TRANSFORMER BAY	1/07/1972	1,600 A	26.20 kA	1.0 s	Not as per Standard Rating
H004-D15-754-	754 FEEDER BAY	1/07/1972	1,600 A	40.00 kA	1.0 s	ok
H004-D17-401-	110kV 3-4 BUS COUPLER BAY	1/07/1972	1,600 A	26.30 kA	3.0 s	Not as per Standard Rating
H004-D18-755-	755 FEEDER BAY	1/07/1972	1,600 A	40.00 kA	1.0 s	Ok
H004-D19-445-	110kV 5 TRANSFORMER BAY	18/03/2017	2,250 A	40.00 kA	1.0 s	Ok
H004-D20-758-	758 FEEDER BAY	1/07/1972	1,600 A	40.00 kA	1.0 s	Ok
H004-D21-757-	757 FEEDER BAY	1/07/1972	1,600 A	40.00 kA	1.0 s	Ok
H004-E11-444-	4 TRANSFORMER 33kV BAY	15/11/2007				
H004-KC--KC1-	275kV 1 BUS	5/07/1999				
H004-KC--KC2-	275kV 2 BUS	5/07/1999				
H004-KD--KD1-	110kV 1 BUS	5/07/1982				
H004-KD--KD2-	110kV 2 BUS	5/07/1982				
H004-KD--KD3-	110kV 3 BUS	5/07/1972				
H004-KD--KD4-	110kV 4 BUS	5/07/1972				

Most of the 110kV bays are below the requirement of the Substation Rating Specification however are likely ‘fit for purpose’. The actual peak load flows should be investigated by planning through joint planning with Energy Queensland to determine if there is a need to uprate equipment.

The 275kV fault level is below the 50kA requirement in the Substation Rating Specification however the current fault level is 9.62 kA and is unlikely to exceed 40kA anytime soon.

The 110kV fault level is below the 40kA requirement in the Substation Rating Specification and the current fault level is 21.4kA. There is also other plant in the 110kV yard that has 25kA and 31.5kA rating but this is sufficient for the current fault level.

1.4 Asset age

The original assets were installed in 1971 and there has been significant replacement and addition of equipment since then, to manage the increasing fault levels and increase in electricity demand.

Upgrades undertaken at this site by Powerlink in the last 20 years include:

- CP.01679 Mudgeeraba 110kV Rebuild
- CP.01288 Mudgeeraba 110kV Substation Refurbishment
- OR.01091 Mudgeeraba 275 kV Bus Upgrade
- CP.01543Mudgeeraba 275/110kV No.2 Transformer Replacement
- OR.01763 ABB 275kV Twin Leg CT Replace Mudgeeraba
- CP.00186 Mudgeeraba 110kV Bay Uprating
- CP.01004 Mudgeeraba 110kV Extension (Varsity Lakes)
- OR.02256 H004 Mudgeeraba Transformer 3 Decommission
- CP.00751 H004 Mudgeeraba CAP Banks Nos 4&5
- OR.01014 Mudgeeraba Security Fencing Upgrade
- OR.00898 Mudgeeraba Substation Civil Works

1.5 Bus arrangement

The substation configuration for 110 kV is of double isolator selectable bus for all bays except No. 2 capacitor bank bay.

The 110 kV busbar configuration contains two coupler bays providing connection between Bus No.1 and Bus No. 3 and Bus No.3 and Bus No.4, respectively and one bus section bay between Bus No.2 and Bus No.4 (bridged, so not to be considered).

There are sixteen 110 kV circuit breakers providing connection for three transformers (two 275/110 kV and one 110/33 kV), ten 110kV transmission circuits, two bus couplers and one capacitor bank.

In the 275 kV yard there is a breaker and half arrangement, with nine 275 kV circuit breakers providing connection to the two 275/110kV transformers, two 275 kV transmission circuits and one capacitor bank including three coupler bays and one spare bay.

1.6 Substation Location and Platform

The substation site area is 17.89 hectares used for both 110 kV and 275 kV switchyards and is located on the Pacific Highway 80kms south of Brisbane in the suburb Varsity Lakes at the southern end of the Gold Coast. A recently conducted flood study for the 110 kV switchyard (Objective Id. A14040498) indicates that under baseline (existing) conditions, the eastern and northern parts of the switchyard are inundated during a 200-year ARI flood event.

The other parts of the substation is flood free. Flood immunity for the 200-year ARI event can be achieved within the switchyard through filling with no adverse upstream or downstream impacts (other than highly localised impacts adjacent to the fill itself). Design fill elevations range between 6.5m AHD and 4.88m AHD. This is typically 0.1m to 0.15m above existing ground levels.

The area surrounding the substation has been developed mainly for residential purposes. The development around the site has resulted in significant drainage issues for the substation site which may impact the total useable area of the site.

1.7 Scope of site condition assessment

The site condition assessment is restricted to Powerlink owned high voltage equipment and associated support structure and site infrastructure at H004 Mudgeeraba substation with the **exclusion** of:

- Protection and control systems which are subject to separate condition assessment report.
- Power Transformers T1, T4 & T5.
- Capacitor Banks No 2, No 3 & No 4.
- Civil/ Structural Condition assessment.
- 110KV substation plant listed below. These equipment in 110kV bays listed in Table 2 were refurbished or replaced to secure a further service life of 40 years.

Table 2-110 kV bays excluded from the scope

Functional Loc.	Description
H004-D22-7839	7839 FEEDER BAY
H004-D15-754-	7542 FEEDER BAY
H004-D21-757-	7572 FEEDER BAY
H004-D20-758-	7582 FEEDER BAY
H004-D18-755-	7552 FEEDER BAY
H004-D04-794-	7942 FEEDER BAY
H004-D11-444-	110kV 4 TRANSF BAY
H004-D19-445-	5 TRANSFORMER 110kV BAY

2. CONDITION ASSESSMENT

2.1 Primary Plant Bays -275 kV

2.1.1 H004-C01-501- 275kV 1 Coupler Bay

Due to RAZ associated with [redacted] in the adjacent bay site inspection of this bay was limited.

The equipment within this bay consists of the following.

Table 3-H004-C01-501

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up Date	CA HI
H004-C01-501--5010-1	EARTH SWITCH	AEM AUSTRALIA	SE362	20037579	29/07/2001	4
H004-C01-501--5010-2	EARTH SWITCH	AEM AUSTRALIA	SE362	20037580	29/07/2001	4
H004-C01-501--5012	CIRCUIT BREAKER	SIEMENS	3AP1-FI-300KV	20036340	27/07/2001	5
H004-C01-501--5018	ISOLATOR	AEM AUSTRALIA	DB362	20037570	29/07/2001	4
H004-C01-501--5019	ISOLATOR	AEM AUSTRALIA	DB362	20037569	29/07/2001	4
H004-C01-501--501CTA	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081033	24/03/2015	2
H004-C01-501--501CTB	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081034	24/03/2015	2
H004-C01-501--501CTC	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081035	24/03/2015	2

Trench CTs in this bay are SF6 insulated with polymer housing and were installed in 2015 as a replacement for ABB Twin leg CTs which had a high explosive failure rate. All other equipment is around 25 years old.

AEM Earth switches previously had signs of corrosion on the 2 ES B phase rod, and 1 ES tie rod ends. Maintenance records show that the B phase rod corrosion was repaired.

Similarly, maintenance records show AEM disconnectors have multiple records of corrosion to rod ends and insulator bolts. The severity of this corrosion could not be assessed on site.

The circuit breaker is of Siemens make with SF6 insulation and spring-operated mechanism. This CB has history of faulty trips during 2021, with cause not being established, but tripping has not been repeated since then. It has corrosion on mechanism box door and on A and C phase cubicles. The operating times of this CB are not recorded. Last service was done in 2014.

Recommendation:
Despite corrosion issues and issues with circuit breaker it is not recommended to replace any equipment in this bay for the next 20 years. It is recommended to ensure there is a suitable spare circuit breaker available in warehouse.

2.1.2 H004 – C01-541 275kV 1 Transformer Bay

Due to Restricted Access Zone (RAZ) associated with [redacted] located in the adjacent bay site inspection of this bay was limited.

The equipment within this bay consists of the following;

Table 4-H004-C01-541

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up Date	CA HI
H004-C01-541--1SAA	SURGE ARRESTOR (GAPLESS)	ASEA	XAQ300A2/240	20002884	24/04/1992	7
H004-C01-541--1SAB	SURGE ARRESTOR (GAPLESS)	ASEA	XAQ300A2/240	20002887	24/04/1992	7
H004-C01-541--1SAC	SURGE ARRESTOR (GAPLESS)	ASEA	XAQ300A2/240	20002886	14/04/1992	7
H004-C01-541--1TRFCTA	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	20002806	24/04/1992	7
H004-C01-541--1TRFCTB	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081032	13/03/2015	2
H004-C01-541--1TRFCTC	CURRENT TRANSFORMER	HAEFELY	IOSK300/1050	20002794	24/04/1992	7
H004-C01-541--5410	EARTH SWITCH	AEM AUSTRALIA	SE362	20037583	30/03/2001	3
H004-C01-541--5410-1	EARTH SWITCH	AEM AUSTRALIA	SE362	20037581	30/03/2001	3
H004-C01-541--5410-2	EARTH SWITCH	RUHRTAL	2AEBF231	20010219	24/04/1992	6
H004-C01-541--5410-3	EARTH SWITCH	AEM AUSTRALIA	SE362	20037582	30/03/2001	4
H004-C01-541--5411	ISOLATOR	AEM AUSTRALIA	DB362	20037572	30/03/2001	4
H004-C01-541--5412	CIRCUIT BREAKER	SIEMENS	3AP1-FI-300KV	20036337	27/07/2001	5
H004-C01-541--5413	ISOLATOR	RUHRTAL	DBF630-2725	20002862	24/04/1992	6
H004-C01-541--5417	ISOLATOR	AEM AUSTRALIA	DB362	20037571	30/03/2001	4

All equipment in the bay are over 24 years, except for the B phase Trench current transformer which is 11 years old and AEM isolators and earth switches. Haefely CTs on A & C phases are oil filled porcelain and have been in service for 34 years but are close to 40 years old. As increased acetylene level in oil samples for this model of current transformer has been detected and considering safety consequences associated with porcelain housed current transformers, the condition of these CTs is monitored closely by taking an annual oil sample. This has impact on the transformer availability as outages are required for oil samples. Whilst DGA analysis is satisfactory for both CTs, there is an increased level of ethane and methane in C phase CT. There are no other defects recorded.

AEM earth switch/disconnector has records of corrosion to B phase rod ends, and water ingress to the cubicle. Ruhrtal Earth switch and disconnector had a few issues which required isolator to be fully disassembled and cleaned and assembled again. The silver coating on the contacts is worn out and any deposits of dirt and mould result in it not being able to be closed. The earth switch tie rod ends have corroded (Grade 1 detected in 2017).

The circuit breaker is Siemens 3AP1-FI-300kV with SF6 insulation and spring-operated mechanism and with porcelain housing. It has performed approx. 370 operations. The operating times of this CB are not recorded. It has a chip to the C phase insulator from 2012 but no other major flags.

The ASEA make Surge arrestors are in porcelain housing and are 34 years old. If they fail catastrophically, they can cause damage to power transformer and other surround equipment. It is not recommended to keep these in service longer than 40 years.

Recommendation:
Based on the above observations, it is recommended to replace the A&C phase CTs along with the SAs and RUHRTAL isolator and earth switch in the next 5 years. As this type of Siemens circuit breakers appear to suffer from early onset of corrosion it is recommended to monitor its condition closely.

2.1.3 H004 - C02-502 - 275kV 2 Coupler Bay

Due to RAZ associated with [redacted] in adjacent bay site inspection of this bay was limited.

The equipment within this bay consists of the following.

Table 5-H004-C02-502

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up Date	CA HI
H004-C02-502--5020-1	EARTH SWITCH	AEM AUSTRALIA	SE362	20037586	30/03/2001	3
H004-C02-502--5020-2	EARTH SWITCH	RUHRTAL	AEBF231	20010217	24/04/1992	4
H004-C02-502--5022	CIRCUIT BREAKER	ABB, SWEDEN	HPL300B1 3PAR	20051449	11/09/2020	4

H004-C02-502--5028	ISOLATOR	RUHRTAL	DBF630-2725	20002867	10/05/1992	4
H004-C02-502--5029	ISOLATOR	AEM AUSTRALIA	DB362	20037575	30/03/2001	3
H004-C02-502--502CTA	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081097	20/10/2015	2
H004-C02-502--502CTB	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081110	20/10/2015	2
H004-C02-502--502CTC	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081112	20/10/2015	2

The circuit breaker in this bay was replaced in 2020 due to unrepairable SF6 leaks associated with the old ASEA circuit breaker. Whilst HPL circuit breakers are known to have issues with the seals resulting in SF6 leaks, this CB is performing satisfactorily, operating times will be checked during service which occurs every 12 years, so not due yet.

Maintenance records show the AEM ESW/disconnector has history of U bolt corrosion, water ingress in mech box, and auxiliary switches out of alignment, leading to isolator not being able to be operated using motor when in local mode. The repairs of U bolt corrosion have been completed. Water ingress into mechanism box is still to be repaired.

Trench CTs in this bay are SF6 insulated with polymer housing and were installed in 2015 as a replacement for ABB Twin leg CTs which had a high explosive failure rate.

Recommendation:
Based on the above observations, no equipment replacements are recommended for another 15-20 years.

2.1.4 H004 - C02 - 597 275kV Spare 7 (C02)

Due to RAZ associated with the [redacted] in the adjacent bay site inspection of this bay was limited.

The equipment within this bay consists of the following.

Table 6-H004-C02-597

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up Date	HI
H004-C02-597--5972	CIRCUIT BREAKER	MITSUBISHI	250-SFM-40B SPAR P	20002730	10/05/1992	7
H004-C02-597--5972CTA	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081103	7/10/2015	2

H004-C02-597--5972CTB	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081105	7/10/2015	2
H004-C02-597--5972CTC	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081106	7/10/2015	2

This bay is mothballed because of the decommissioning of Transformer T2.

Recommendation:

Considering that circuit breaker in this bay is SF6 CB with pneumatic mechanism and not supported by the manufacturer for many years now and condition issues associated with air leaks and compressor failures as well as skills set required to maintain this type of circuit breaker, it is recommended to remove this circuit breaker from site and keep re-useable spare parts.

2.1.1 H004 - C02 - 835 Greenbank Feeder 835 bay

Due to RAZ associated with the [redacted] in the adjacent bay site inspection of this bay was limited.

The equipment within this bay consists of the following.

Table 7-H004-C02-853

Functional Loc.	Description	Manufacturer	Model number	Equipment number	Start-up Date	CA HI
H004-C02-835--12VTA	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TCVT300C	20077270	9/06/2013	3
H004-C02-835--12VTB	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TCVT300C	20077287	9/06/2013	3
H004-C02-835--12VTC	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TCVT300C	20077257	9/06/2013	3
H004-C02-835--8350	EARTH SWITCH	RUHRTAL	2AEBF231	20010237	10/05/1992	4
H004-C02-835--8350-1	EARTH SWITCH	AEM AUSTRALIA	SE362	20037584	30/03/2001	4
H004-C02-835--8350-2	EARTH SWITCH	AEM AUSTRALIA	SE362	20037585	30/03/2001	4
H004-C02-835--8350-3	EARTH SWITCH	RUHRTAL	2AEBF231	20010238	10/05/1992	4
H004-C02-835--8351	ISOLATOR	RUHRTAL	DBF630-2725	20002863	10/05/1992	5
H004-C02-835--8352	CIRCUIT BREAKER	SIEMENS	3AP1-FI-300KV	20036339	27/07/2001	6

H004-C02-835--8353	ISOLATOR	AEM AUSTRALIA	DB362	20037573	30/03/2001	3
H004-C02-835--8357	ISOLATOR	AEM AUSTRALIA	DB362	20037574	30/03/2001	3
H004-C02-835--835CTA	CURRENT TRANSFORMER (SF6 - GAS)	MWB TRENCH	SAS300/9G	20080510	22/03/2014	3
H004-C02-835--835CTB	CURRENT TRANSFORMER (SF6 - GAS)	MWB TRENCH	SAS300/9G	20080511	22/03/2014	3
H004-C02-835--835CTC	CURRENT TRANSFORMER (SF6 - GAS)	MWB TRENCH	SAS300/9G	20080512	22/03/2014	3
H004-C02-835--835SAA	SURGE ARRESTER	SIEMENS	POLYMER H/POLL 240KV	20086474	8/06/2016	2
H004-C02-835--835SAB	SURGE ARRESTER	SIEMENS	POLYMER H/POLL 240KV	20086475	8/06/2016	2
H004-C02-835--835SAC	SURGE ARRESTER	SIEMENS	POLYMER H/POLL 240KV	20086476	8/06/2016	2

Most of the equipment in this bay was replaced in period 2001 to 2016 due to the identified various risks associated with the high voltage equipment. CTs in this bay were ABB twin leg CTs which experienced increased number of catastrophic failure and have been considered as high safety risk for personnel. These were replaced in 2014. CVTs were replaced a year earlier due to the moisture ingress into electromagnetic unit resulting in a loss of secondary voltage. The onset of this failure mode is identified through oil colour change in oil glass.

AEM earth switch/disconnectors despite being relatively new, have corroded tie rod ends and insulator jacking bolts. In addition, disconnector has issues with limit switch resulting in motorised function not being available as seen in Figure 6 and Figure 7.

Figure 6--Limit switch and chain drive assembly

Figure 7-Removed NHP limit switch component

Maintenance records show that Siemens CB in this bay has a history of SF6 leaks between 2002 to 2018 to a point that C phase CB pole had to be replaced. No SF6 leaks were detected since then. The operating times of this CB are not available in CMMS.

Ruhrtal isolator seem to be in good condition as the only defects recorded were in 2013 and 2017. Earth switches have records related to onset of corrosion on drive linkages.

Recommendation:
Based on the above observations, it is not recommended to replace any equipment in this bay. It is expected that it will provide reliable service for next 15-20 years.

2.1.2 H004 - C03 - 503 - 275kV 3 Coupler Bay (C03)

Due to RAZ associated with the [redacted] in the adjacent bay site inspection of this bay was limited.

The equipment within this bay consists of the following.

Table 8- H004-C03-503

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up date	CA HI
H004-C03-503--5030-1	EARTH SWITCH	AEM AUSTRALIA	SE362	20037590	30/03/2001	4
H004-C03-503--5030-2	EARTH SWITCH	RUHRTAL	AEBF231	20010218	24/04/1992	5
H004-C03-503--5032	CIRCUIT BREAKER (SF6 SPRING MultiVol)	ABB, SWEDEN	HPL300B1 3PAR	20125567	31/07/2020	3
H004-C03-503--5038	ISOLATOR	RUHRTAL	DBF630-2725	20002864	24/04/1992	5
H004-C03-503--5039	ISOLATOR	AEM AUSTRALIA	DB362	20037578	30/03/2001	4
H004-C03-503--503CTA	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081098	8/09/2015	2
H004-C03-503--503CTB	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081101	8/09/2015	2
H004-C03-503--503CTC	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081109	8/09/2015	2

AEM earth switch is over 20 years old and has history of corrosion on jacking bolts, insulator U bolts, and tie rod ends. Ruhrtal ES/disconnector slightly older with no noted signs of corrosion. However, sometimes it has issues with remote closing.

ABB circuit breaker in this bay was installed in 2020 as a replacement for unrepairable ASEA CB of similar model which exhibited numerous SF6 leaks which could not be repaired. Similarly to other HPL300 B1 circuit breakers in Powerlink's network, this

circuit breaker installed in this bay in 2020 has multiple issues related to SF6 leak. However, no SF6 leak events are recorded post September 2023.

Trench current transformers were also installed as replacement for ABB twin leg CTs. Trench SF6 CTs have faded SF6 gauges on the A & B phases.

Recommendation:
Based on the above observations, no equipment's are required to be replaced in this bay this bay for another 15-20 years.

2.1.3 H004-C03-545 - 275kV 5 Transformer Bay (C03)

The equipment within this bay consists of the following.

Table 9-H004-C03-545

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up Date	CA HI
H004-C03-545--5450	EARTH SWITCH	ALSTOM	M/POL 9.0M	20087960	23/05/2017	7
H004-C03-545--5450-1	EARTH SWITCH	RUHRTAL	AEBF231	20010225	24/04/1992	5
H004-C03-545--5450-2	EARTH SWITCH	RUHRTAL	AEBF231	20010226	24/04/1992	5
H004-C03-545--5450-3	EARTH SWITCH	ALSTOM	M/POL 9.0M	20088135	23/05/2017	7
H004-C03-545--5451	ISOLATOR (MOTORISED)	ALSTOM	M/POL 9.0M	20088134	23/05/2017	7
H004-C03-545--5452	CIRCUIT BREAKER	MITSUBISHI	250-SFM-40B SPAR P	20002729	24/04/1992	7
H004-C03-545--5452CTA	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081104	22/09/2015	2
H004-C03-545--5452CTB	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081102	22/09/2015	2
H004-C03-545--5452CTC	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081107	22/09/2015	2
H004-C03-545--5453	ISOLATOR	RUHRTAL	DBF630-2725	20002865	24/04/1992	5
H004-C03-545--5457	ISOLATOR	RUHRTAL	DBF630-2725	20002861	24/04/1992	5
H004-C03-545--5SAA	SURGE ARRESTOR (GAPLESS)	SIEMENS	3EQ4 240-2PV31-4KAI	20048593	13/10/2005	3
H004-C03-545--5SAB	SURGE ARRESTOR (GAPLESS)	SIEMENS	3EQ4 240-2PV31-4KAI	20048594	13/10/2005	3
H004-C03-545--5SAC	SURGE ARRESTOR (GAPLESS)	SIEMENS	3EQ4 240-2PV31-4KAI	20048595	13/10/2005	3

Majority of the equipment in this bay was replaced in the last 10 years, including installation of Trench current transformers and Alstom earth switches and disconnector.

The Siemens surge arrestors are in relatively good condition and should be only replaced when 5T is replaced.

The Ruhrtal isolators and earth switches and circuit breaker have been in service now for 33 years. The circuit breaker (CB) in this bay was manufactured by Mitsubishi. It has a pneumatic/ spring type operating mechanism with SF6 gas used as insulating medium. This type of CB is no longer manufactured by Mitsubishi and hence no spare parts support. It is showing signs of deterioration.

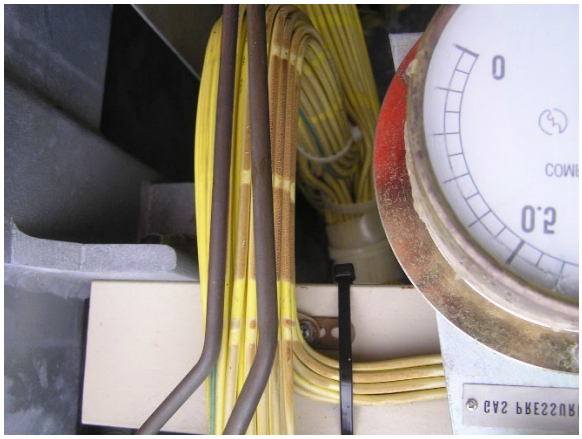


Figure 8- UV damage to internal wiring and the operation counter

Notably, the panel glass is not UV tinted, resulting in UV damage to internal wiring and the operation counter as shown in Figure 8.

The Kaji compressor also has an ongoing hydraulic oil leak and air leaks, leading to air compressor motor burnout., The operating times are not available.

Ruhrtal disconnectors have some lightly corroded nuts and bolts on the structure, and light wear on earth switch rotating axel but otherwise seem to be in good condition. The motor box is equipped with fuses rather than MCBs showing the age of manufacture. However, there are no recorded defects associated with RUHRTAL disconnectors and earth switches.

Figure 9- Visible corrosion on disconnector

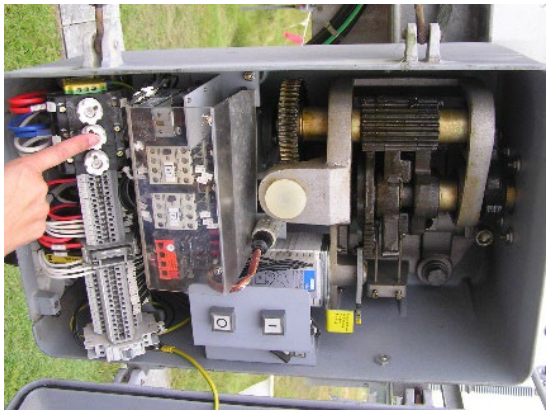


Figure 10- Earth switch/ disconnector control box

On the other hand, Alstom isolator 5451 had to be derated as it is not closing properly since 2017. Despite multiple attempts to repair it, this issue is still unresolved. The associated earth switches 5450 and 5450/3 have also several misalignment issues and damage.

This equipment condition highlights the need to assess options for refurbishment or replacement to ensure ongoing reliability and safety.

Recommendation:
Based on the above observations, it is recommended to replace the Mitsubishi circuit breaker in the next 5 years along with its structure and foundation. The failure of this CB can cause reduced operational flexibility for transformer switching and potentially can cause transformer damage due to delayed fault clearing.

It is also recommended to replace Alstom disconnector 5451 with associated earth switches 5450 and 5450/3 within next 5 years.

2.1.4 836 Greenbank Feeder Bay (C03)

Due to RAZ associated with the [redacted] in the adjacent bay site inspection of this bay was limited.

The equipment within this bay consists of the following.

Table 10- H004-C03-836

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up Date	CA HI
H004-C03-836--13VTA	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TEMP287C	20066799	23/10/2011	4
H004-C03-836--13VTB	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TCVT300C	20077289	8/06/2013	3
H004-C03-836--13VTC	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TCVT300C	20077291	8/06/2013	3
H004-C03-836--8360	EARTH SWITCH	RUHRTAL	2AEBF231	20010239	24/04/1992	3
H004-C03-836--8360-1	EARTH SWITCH	AEM AUSTRALIA	SE362	20037587	30/03/2001	3
H004-C03-836--8360-2	EARTH SWITCH	AEM AUSTRALIA	SE362	20037588	30/03/2001	3
H004-C03-836--8360-3	EARTH SWITCH	RUHRTAL	2AEBF231	20010240	24/04/1992	3
H004-C03-836--8361	ISOLATOR	RUHRTAL	DBF630-2725	20002860	24/04/1992	4
H004-C03-836--8362	CIRCUIT BREAKER	SIEMENS	3AP1-FI-300KV	20036338	27/07/2001	5

H004-C03-836--8363	ISOLATOR	AEM AUSTRALIA	DB362	20037576	30/03/2001	3
H004-C03-836--8367	ISOLATOR	AEM AUSTRALIA	DB362	20037577	30/03/2001	3
H004-C03-836--836CTA	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081036	10/04/2015	3
H004-C03-836--836CTB	CURRENT TRANSFORMER (OIL)	ABB AUSTRALIA	IMB300C6H4	20071496	6/12/2013	9
H004-C03-836--836CTC	CURRENT TRANSFORMER (SF6)	TRENCH	SAS 300/9G	20081037	10/04/2015	3
H004-C03-836--836SAA	SURGE ARRESTER	SIEMENS	POLYMER H/POLL 240KV	20086477	9/06/2016	2
H004-C03-836--836SAB	SURGE ARRESTER	SIEMENS	POLYMER H/POLL 240KV	20086478	9/06/2016	2
H004-C03-836--836SAC	SURGE ARRESTER	SIEMENS	POLYMER H/POLL 240KV	20086479	9/06/2016	2

As it can be seen form the Table above, most equipment in this bay was replaced in period from 2001 to 2016 for various reasons. CTs were replaced as there were ABB twin leg CTs with restricted access zone around them for some period. Voltage transformers were replaced as they were failing with oil colour being detected as very dark in 2012 (observed in may Trench CVTs prior to loosing secondary voltage),

Trench CVTs (according to manufacturer with improved design) and Siemens surge arrestors all observed to be in good condition.

Ruhrtal disconnector had one issue recorded in 2017 where it could not be open remotely. It has sticky limit switch but is also a disconnector that opened relatively slowly so control system required adjustment. The repair was obviously successful as it was not repeated. No defects were identified on Ruhrtal earth switches. AEM earth switch/disconnectors have notifications relating to tie rod ends corroding, corrosion in insulator jacking bolts, and U bolts. There are also instances of high resistance, failing to open or close remotely.

Notifications for the Siemens circuit breaker indicate corrosion on the C phase mech box. This rust has been removed since and re-painted.

Recommendation:

Based on the above observations, the recommendation is NOT to replace any equipment in this bay over next 15-20 years. Based on the above observations, only IMBM 300 CTs require replacement in the next 3-5 years. Please note that their replacement is already included in IMB300 CT replacement project.

It is also recommended to investigate refurbishment options for AEM disconnector.

2.1.5 275kV 4 Capacitor Bank Bay (C51)

Due to RAZ associated with the [redacted] in this and the adjacent bays site inspection of this bay was limited.

The equipment within this bay consists of the following.

Table 11-H004-C51-584

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up date	CA HI
H004-C51-584—5840	EARTH SWITCH	AEM AUSTRALIA	SE300	20042677	13/09/2002	4
H004-C51-584--5840-2	EARTH SWITCH	AEM AUSTRALIA	SE300	20042676	13/09/2002	4
H004-C51-584—5842	CIRCUIT BREAKER	SIEMENS	3AP1-FI-300KV	20041927	1/11/2002	5
H004-C51-584--5842CTA	CURRENT TRANSFORMER	ABB AUSTRALIA	IMBM300C6T9	20041903	28/10/2002	9
H004-C51-584--5842CTB	CURRENT TRANSFORMER	ABB AUSTRALIA	IMBM300C6T9	20041904	28/10/2002	9
H004-C51-584--5842CTC	CURRENT TRANSFORMER	ABB AUSTRALIA	IMBM300C6T9	20041905	28/10/2002	9
H004-C51-584—5843	DISCONNECTOR (MOTORISED)	AEM AUSTRALIA	DB300	20042678	13/09/2002	4

This bay and cap bank were added later and therefore all equipment is just over 20 years old. AEM earth switch/disconnector has history of rod end corrosion and water ingress in the cubicle, similar to other AEM disconnectors and earth switches in this substation.

Siemens circuit breaker had some parts failing but all have been replaced.

[redacted]

Recommendation:

Based on the above observations, only IMBM 300 CTs require replacement in the next 3-5 years. Please note that their replacement is already included in IMB300 CT replacement project.

2.2 Primary Plant Bays -110 kV

2.2.1 706 Nerang Feeder Bay (D05)

The equipment within this bay consists of the following;

Table 12- H004-D05-706

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up Date	CA HI

H004-D05-706--7060	EARTH SWITCH	TAPLIN	145E/B128	20010236	1/07/1981	7
H004-D05-706--7061	ISOLATOR	TAPLIN	145RC/B125	20002847	24/04/1992	7
H004-D05-706--7062	CIRCUIT BREAKER	ASEA	HLD145/1250C OIL	20002722	1/07/1981	8
H004-D05-706--7065	ISOLATOR	TAPLIN	145RC/B125	20002844	1/01/1981	7
H004-D05-706--7066	ISOLATOR	TAPLIN	145RC/B125/2	20002822	1/01/1981	7
H004-D05-706--706CTA	CURRENT TRANSFORMER (OIL)	KONCAR	AGU-145 6 Core 2500	20074648	8/09/2017	3
H004-D05-706--706CTB	CURRENT TRANSFORMER (OIL)	KONCAR	AGU-145 6 Core 2500	20071506	8/09/2017	2
H004-D05-706--706CTC	CURRENT TRANSFORMER (OIL)	KONCAR	AGU-145 6 Core 2500	20071505	1/11/2011	3

Koncar current transformers were recently installed replacing ASEA IMBD145A5 CTs which replaced due to the increased number of catastrophic failures. These are in good condition. Their support structures and interface to the concrete foundations were also replaced at this time as previous civil inspection condition assessment noted considerable levels of corrosion.

All other equipment is over 45 years old and in deteriorated condition. Previous condition assessment noted the deterioration was not visually identifiable.

The ASEA circuit breaker (CB) is minimum oil type HLD. The breaking unit consists of an oil container with an arc-control device of the cross-blast type. The oil container consists of a porcelain tube reinforced with a glass fibre tube on the inside, fixing flanges, a mechanism-housing cast in light metal and a gas tight top. The-breaking unit is hermetically sealed and pressurised with nitrogen gas. Minimum oil type breakers are an obsolete technology, ASEA was merged with Brown Boveri and traded as ABB. ABB has stopped manufacturing these circuit breakers in 1992 and was sold to Hitachi which does not provide technical support and spare parts for these breakers anymore.

The maintenance records revealed the ASEA circuit breaker suffered from low insulation readings due to the moisture ingress, as well as oil leaks.

These circuit breakers require specific maintennace skills and oil replacament and clean up every 2 years to mainatin satisfactory insulation level.

Figure 11- Photo of Equipment

Figure 12-Photo of Equipment

The RC type Taplin disconnectors in this bay have experienced high resistance and overheating associated with the current carrying pivot joints. The original design has the pivot joints exposed to the elements and degradation occurs with these components over time. Under OR.01041 project the installation of new braid assemblies at the pivot joints and included the upgrade of the current carrying contact female contacts fingers system to 8 fingers / resilvering the male contact and the in addition to the new braid assemblies at the pivot joints. The disconnector 7066 has a fault rating of 25 kA which is well below the standard rating of 40kA, and the 110kV fault level is 21.5KA and trending upwards. Last year it was established that due to the shaft rid being bent all cam shaft rotating discs were out of alignment resulting in the status of isolator being undetermined (not open nor closed). This was rectified but it is likely to re-occur.
These Taplin disconnectors also have low continuous current rating of 1250 A.

Figure 13- Photo of Equipment

Figure 14- Photo of Equipment

Recommendation:

There is a network vulnerability associated with this feeder 706 which supplies Nerang area at Gold Coast. When this network element is lost, Nerang can be supplied from Molendinar substation via F798. The loss of that feeder at the same time would results in load shedding.

Based on the above observations, it is recommended to replace the CB and disconnectors in this bay in the next 5 years along with their associated structures and foundations.

2.2.2 110kV 2 Capacitor Bay (D06)

The equipment within this bay consists of the following.

Table 13- H004-D06-482

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up date	CA HI
H004-D06-482—4820	EARTH SWITCH	GENERAL ELECTRIC CO.	123KV 25KA	20014660	1/01/1981	7
H004-D06-482—4821	ISOLATOR	SEC Australia Ltd	DBR4	20002821	1/01/1981	7
H004-D06-482—4822	CIRCUIT BREAKER (SF6 SPRING SinglVol)	ABB	LTB145D1/BUS	20049607	02/07/2011	7
H004-D06-482--4822CTA	CURRENT TRANSFORMER	ABB	169869	20011917	17/07/1996	7
H004-D06-482--4822CTB	CURRENT TRANSFORMER	LOW+BONAR STANGER	B66705	20002788	18/12/1994	7
H004-D06-482--4822CTC	CURRENT TRANSFORMER	LOW+BONAR STANGER	B66705	20002740	18/12/1994	7
H004-D06-482—4823	ISOLATOR	TAPLIN	145RC/B125	20002843	1/01/1981	8

The ABB breaker presently in this bay was previously installed at H016 (Rocklea) substation between 2005 and 2011 when it had operating rod failure. It was refurbished/repair and installed in this bay after 1994 manufactured breaker of similar design failed. Maintenance records show records of severe SF6 pipework oxidisation in 2021 which had to be replaced incurring significant cost of over $50k and requiring SF6 gas replacement as well. The outstanding defects are related to SF6 gauge fading. This breaker has performed almost 3000 operations. Its operating mechanism is rated for 10000 operations.

CT A phase was also replaced in December 2013 due to oil leaks from the secondary terminal box. The current transformer used for replacement was previously installed at H003 Belmont since 1996 to 2011 when it was recovered as a part of decommissioning of bay associated with transformer T3 at Belmont. The B&C phase Low-Bonar Stanger current transformers, where manufactured in 1980 and were installed at Mudgeeraba in 1994. There is light corrosion to B and C phase. B and C are both 45 years old. and it is recommended to replace these soon. Statistical data indicate that oil filled current transformers have increased probability of explosive failures after 37 years in service. As they have porcelain housing potentially catastrophic safety consequences can occur and on this basis it is recommended to have these replaced within 3-5 years.

Figure 15- Photo of Equipment

Figure 16- Photo of Equipment

The earth switch and two disconnectors in this bay are 45 years old. The disconnectors in this part of the 110 kV yard are showing some signs of corrosion but to a lesser degree compared to those located at the northern part of the yard. Significant investment had to be undertaken to improve Taplin disconnectors design and to eliminate high resistance points in the current path. This has resulted in an increase in the health index.

Recommendation:

Any equipment failure in this bay can cause capacitor bank not to be available for switching during high load periods. Considering there is another cap bank at this site (4 cap) albeit connected to 275 kV bus, the need for 2 Cap needs to be confirmed by network planning and operation engineers. Based on the usage data showed below, it is likely there is an enduring need for it.

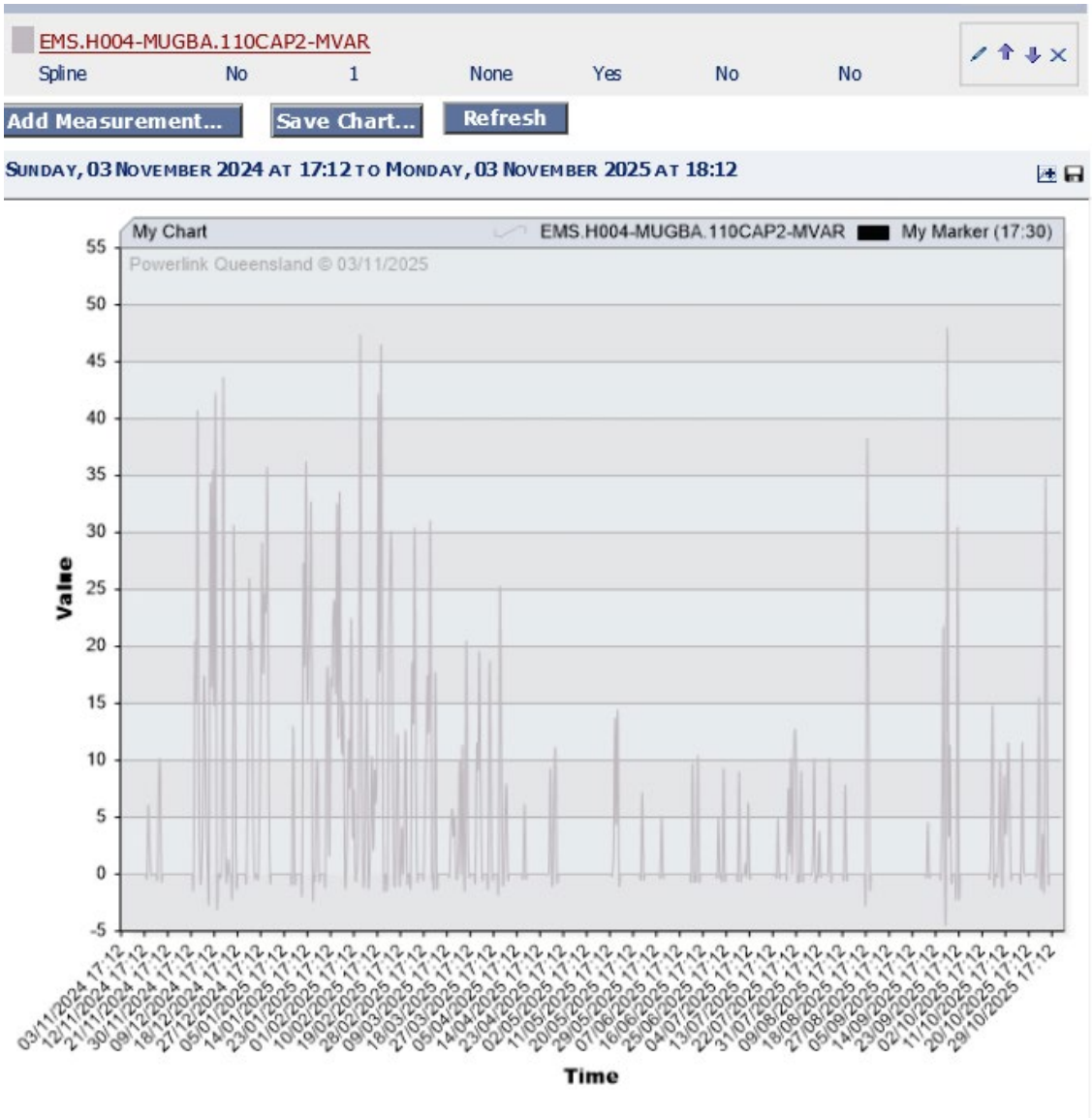


Figure 17- EMS 110 kV CAP2 Graph

Considering the condition and maintenance history of the equipment in this bay but also the age and condition of the capacitor bank (29 years old), it is recommended to replace two LOW+BONAR STANGER CTs in this bay within next 3-5 years and replace all other equipment in 10 years with the cap bank replacement, if the enduring need remains.

2.2.3 779 Merrimac Feeder Bay (D07)

The equipment within this bay consists of the following;

Table 14- H004-D07-779

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up Date	CA HI
H004-D07-779--7790	EARTH SWITCH	ALSTOM	MAN 4.7M	20087959	23/05/2017	2
H004-D07-779--7791	DISCONNECTOR (HAND OPERATED)	ALSTOM	S3C2T	20087957	23/05/2017	2
H004-D07-779--7792	DEAD TANK CIRCUIT BREAKER (SF6 SPR 1Vol)	MITSUBISHI	120-SFMT-40E	20081881	23/05/2017	2
H004-D07-779--7795	ISOLATOR	TAPLIN	145RC/B125	20002841	1/01/1981	7
H004-D07-779--7796	ISOLATOR	TAPLIN	145RC/B125/2	20002839	1/01/1981	7

Alstom Earth switch and 7791 Isolator were replaced in 2017 along with Mitsubishi dead tank circuit breaker. These are in good condition.

Remaining Taplin Isolators are approaching 50 years old. These isolators showed signs of corrosion on interphase operating shafts similar to those in 780 Merrimac Bay. Notifications note corrosion to the operating rods of these isolators. The RC type Taplin disconnectors in this bay have a history of high resistance and overheating associated with the current carrying pivot joints.

Under OR.01041 project the installation of new braid assemblies at the pivot joints and included the upgrade of the current carrying contact female contacts fingers system to 8 fingers / resilvering the male contact and the in addition to the new braid assemblies at the pivot joints. These disconnectors have a short circuit rating of 26.04 kA which is well below the standard rating of 40kA but it is still adequately rated for current 110kV fault level of 21.5kA.

The corrosion was treated in 2020 with a very high costs (using live substation crew) but the corrosion is still present especially on operating rods. These were not replaced in 2018 as decision re bus configuration was not made – this is isolator selectable busbar configuration and requires different and more expensive type of protection. Considering this configuration is kept at this site, these disconnectors now need to be refurbished or replaced.

Figure 18- Photo of Equipment

Recommendation:
Based on the above observations, it is recommended to refurbish or replace two Taplin disconnectors in this bay in the next 5 years along with their structures and foundations.

2.2.4 780 Merrimac Feeder Bay (D08)

The equipment within this bay consists of the following;

Table 15- H004-D08-780

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up Date	CA HI
H004-D08-780--7800	EARTH SWITCH	ALSTOM	MAN 4.7M	20090166	20/10/2017	2
H004-D08-780--7801	DISCONNECTOR (HAND OPERATED)	ALSTOM	S3C2T	20087958	20/10/2017	2
H004-D08-780--7802	DEAD TANK CIRCUIT BREAKER (SF6 SPR 1Vol)	MITSUBISHI	120-SFMT-40E	20081880	20/10/2017	4
H004-D08-780--7805	ISOLATOR	TAPLIN	145RC/B125	20002842	1/01/1981	8
H004-D08-780--7806	ISOLATOR	TAPLIN	145RC/B125/2	20002840	1/01/1981	8

Alstom Earth switch and 7801 Isolator were replaced in 2018 along with Mitsubishi CB. These are in good condition.

Remaining Taplin Isolators are approaching 50 years old. These isolators showed signs of corrosion on interphase operating shafts like those in 779 Merrimac Bay. Notifications note corrosion to the operating rods of these isolators. The RC type Taplin

disconnectors in this bay have a history of high resistance and overheating associated with the current carrying pivot joints. Under OR.01041 project the installation of new braid assemblies at the pivot joints and included the upgrade of the current carrying contact female contacts fingers system to 8 fingers / resilvering the male contact and the in addition to the new braid assemblies at the pivot joints. These were not replaced in 2018 as decision re bus configuration was not made – this is isolator selectable busbar configuration and requires different and more expensive type of protection. Considering this configuration is kept at this site, these disconnectors now need to be refurbished or replaced.

Recommendation:
Based on the above observations, it is recommended to refurbish or replace two Taplin disconnectors in this bay in the next 5 years along with their structures and foundations.

2.2.5 Spare 1 Bay (D09)

The equipment within this bay consists of the following;

Table 16-H004-D09-491

Functional Loc.	Description	Manufacturer	Equipment Number	Model number	Start-up Date	CA HI
H004-D09-491--4915	ISOLATOR (NO ARMS - SPARE)	TAPLIN	*20002856*	110RC/C698/1	1/01/1972	7
H004-D09-491--4916	ISOLATOR (NO ARMS - SPARE)	TAPLIN	20011942	110RC/C698/1	1/01/1972	7

Figure 19- Photo of Equipment

The disconnectors have been disabled and are no longer required from an operational perspective. The arms have been removed for spares. They serve as busbar supports. They need to be monitored to ensure their fault level ratings is not exceeded by fault levels at this site. It is also suspected these are segmented insulators and not passing test.

Recommendation:
Confirm if these are segmented insulators and if they are, they need to be removed and replaced by busbar support insulators. If not, monitor their rating. Pls note these are not shown on operational single line diagram.

2.2.6 110kV 1 Transformer Bay (D10)

The equipment within this bay consists of the following.

Table 17-H004-D10-441

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up Date	CA HI
H004-D10-441--10VTB	CAPACITOR VOLTAGE TRANSFORMER	GE GRID SOLUTIONS INDIA	CCV 170	20131943	11/11/2022	2
H004-D10-441--1SAA	SURGE ARRESTOR (GAPLESS)	ASEA	XAR123A2/96SP	20002878	24/04/1992	6
H004-D10-441--1SAB	SURGE ARRESTOR (GAPLESS)	ASEA	XAR123A2/96SP	20002879	24/04/1992	6
H004-D10-441--1SAC	SURGE ARRESTOR (GAPLESS)	ASEA	XAR123A2/96SP	20002880	24/04/1992	6
H004-D10-441—4410	EARTH SWITCH	WESTRALIAN TRANSF	ES110	20002810	24/04/1992	4
H004-D10-441—4412	CIRCUIT BREAKER	SPRECHER ENERGIE AUS	HGF312 3PAR P	20002733	24/04/1992	7
H004-D10-441--4412CTA	CURRENT TRANSFORMER	ABB	06/123/30	20002748	24/04/1992	7
H004-D10-441--4412CTB	CURRENT TRANSFORMER	ABB	06/123/30	20002746	24/04/1992	7
H004-D10-441--4412CTC	CURRENT TRANSFORMER	ABB	06/123/30	20002743	24/04/1992	7
H004-D10-441—4415	DISCONNECTOR (HAND OPERATED)	AEM AUSTRALIA	DB145	20132425	25/08/2022	2
H004-D10-441—4416	DISCONNECTOR (HAND OPERATED)	AEM AUSTRALIA	DB145	20132424	19/08/2022	2

GE CVT was replaced in 2022 due to moisture ingress and shows no sign of deterioration. It was also previously replaced in 2011 due to high acetylene level in the oil sample from the main tank, indicating typical failure mode for Trench Electric CVTs.

AEM 1 and 2 bus disconnectors replaced original 1970's and 1980's plant. The equipment is over 10 years old and has history of corrosion to insulator mounting bolts, tie rod ends, and water ingress into cubicle.

All other equipment is over 30 years old. Though ASEA surge arrestors are approaching end of service life, there have been no significant deterioration to condition since last condition assessment in 2014. It is also best to replace these surge arrestors when power transformer is replaced.

The circuit breaker (CB) in this bay is a Sprecher installed in 1992. It has a motor wound operating mechanism with spring used for energy storage and SF6 gas as insulating medium. Maintenance records show SF6 gauge is unreadable due to the UV damage. Sprecher has stopped manufacturing high voltage CBs and sourcing spare parts is already difficult. Only twelve circuit breakers of this model are still in service, three of them at Mudgeeraba. It is estimated that it can remain in service with reduced availability and increased maintenance costs for another 5 years.

The ABB current transformers are in service for 33 years and DGA results are satisfactory. The moisture levels seem to be trending upwards for all three phases, the highest level being in C phase. These CTs are oil-filled with porcelain housings and as their insulation ages, there is an increased risk of explosive failure, which presents a significant safety hazard.

Recommendation:

As there are only two 275/110 kV transformers at this site, loss of one transformer should not result in significant load loss. However, any catastrophic failure of the equipment in this bay can cause damage in the adjacent bays such as bus coupler bay or 4T bay which can lead to the load loss. It is expected that Gold Coast will host some of 2032 Olympic Games sport events, which further adds to the importance of having reliable supply in Gold Coast area.

Based on the above observations, it is recommended to replace the CB and CTs in this bay in the next 5 years along with associated structures and foundations.

2.2.7 110kV 1-3 Bus Section Bay (D13)

The equipment within this bay consists of the following equipment.

Table 18- H004-D13-411

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up date	CA HI
H004-D13-411--1BUSCTA	CURRENT TRANSFORMER	ABB	06/123/30	20002745	12/02/1992	7
H004-D13-411--1BUSCTB	CURRENT TRANSFORMER	ABB	06/123/30	20002744	12/02/1992	7

H004-D13-411--1BUSCTC	CURRENT TRANSFORMER	ABB	06/123/30	20002750	12/02/1992	7
H004-D13-411--3BUSCTA	CURRENT TRANSFORMER	ABB	06/123/30	20002757	12/02/1992	7
H004-D13-411--3BUSCTB	CURRENT TRANSFORMER	ABB	06/123/30	20002747	12/02/1992	7
H004-D13-411--3BUSCTC	CURRENT TRANSFORMER	ABB	06/123/30	20002749	12/02/1992	7
H004-D13-411--4112	CIRCUIT BREAKER	SPRECHER ENERGIE AUS	HGF312 3PAR P	20002734	12/02/1992	8
H004-D13-411--4117	ISOLATOR	TAPLIN	110RCE/C817	20002816	1/01/1972	8
H004-D13-411--4118	ISOLATOR	TAPLIN	110RCE/C817	20002857	1/01/1972	8

All equipment in this bay is over 30 years old. All six current transformers are oil filled ABB current transformers with increased moisture levels (in high 30 ppm) and trending upwards for all six CTs. Moisture can compromise the dielectric strength of paper insulation increasing the risk of partial discharges and insulation breakdown. Under fault conditions or switching transients, it is possible for moisture to vaporize rapidly and cause internal pressure buildup, leading to explosion or rupture of the CT.

There was a minor valve leak recorded on C phase 1 Bus CT in early 2024, and then slightly low oil levels on all three phases due to sample point leak later in 2024. These ABB current transformers are in service for 33 years and are oil-filled with porcelain housings and therefore after long exposure to electric field are susceptible to sudden explosive failures, which present a significant safety hazard, if personnel or public is within 90 m of their location at time of failure.

This Sprecher circuit breaker is like the CB in bay D10. This one has UV damage to sight glass making it difficult to see through and not being able to read the SF6 gauge. Additionally, the new wires in the mechbox from when the CB was rewired have caused the gland plate to bow and restrict the door from closing fully. Measured CB operating times are within the limits, but close/trip times are increasing indicating that this CB is getting slower.

Figure 20- Corrosion on disconnector

Two disconnectors in this bay have significant corrosion of the operating interphase shaft (and its ends) and the civil condition assessment report suggests that the estimated remaining service life for their foundations and structures is 5 years. The 26.3kA fault rating of the disconnectors meets current requirements but does not allow for an increase of fault levels (which may limit the possibilities for network re-configurations). The estimated remaining service life for these disconnectors is 3-5 years.

Recommendation:

As the disconnectors 4128 and 4127 in D13 (Bus section bay) are bridged, an equipment failure in this bus coupler bay may lead to overload of T5 as all loads normally connected to buses 3, 4 and 2 will be supplied via T5 until the switching of disconnectors can be done to re-balance loads between T5 and T1 (normally connected to bus 1). As 110 kV disconnectors are no motorised switching crews would need to be deployed to Mudgeeraba if this is to occur.

Based on the above observations, it is recommended to replace all equipment in this bay in the next 5 years along with associated structures and foundations.

2.2.8 110kV 2-4 Bus Section Bay (D13)

The equipment within this bay consists of the following.

Table 19- H004-D13-412

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up Date	CA HI
H004-D13-412—4127	ISOLATOR	TAPLIN	110 RCE/C817	20002853	1/01/1972	7
H004-D13-412—4128	ISOLATOR	TAPLIN	110 RCE/C817	20002858	1/01/1972	8

Both disconnectors have been bridged and disabled and are no longer functional. Considering there are two coupler bays in 110 kV switchyard, these disconnectors are not required further. They are however in severely corroded state and are of segmented type, failing audible tests.

Recommendation:

It is recommended that these are decommissioned and replaced with post insulators.

Figure 21-Bridged Disconnectors

2.2.9 838 Varsity Lakes Feeder Bay (D16)

The equipment within this bay is listed below.

Table 20- H004-D16-7838

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up date	CA HI
H004-D16-7838-18VTA	CAPACITOR VOLTAGE TRANSFORMER	TRENCH	TEMP115	20049402	28/09/2005	6
H004-D16-7838-18VTB	CAPACITOR VOLTAGE TRANSFORMER	TRENCH	TEMP115	20049403	28/09/2005	6
H004-D16-7838-18VTC	CAPACITOR VOLTAGE TRANSFORMER	TRENCH	TEMP115	20049404	28/09/2005	6
H004-D16-7838-78380	EARTH SWITCH	AEM AUSTRALIA	SE145	20049415	28/09/2005	3
H004-D16-7838-78381	DISCONNECTOR (HAND OPERATED)	AEM AUSTRALIA	DB145	20049411	28/09/2005	3

H004-D16-7838-78382	CIRCUIT BREAKER (SF6 SPRING SinglVol)	ABB SWEDEN	LTB145D1/B	20049397	28/09/2005	5
H004-D16-7838-78382CTA	CURRENT TRANSFORMER (OIL)	ARTECHE	CA-123	20049393	28/09/2005	4
H004-D16-7838-78382CTB	CURRENT TRANSFORMER (OIL)	ARTECHE	CA-123	20049394	28/09/2005	4
H004-D16-7838-78382CTC	CURRENT TRANSFORMER (OIL)	ARTECHE	CA-123	20049395	28/09/2005	4
H004-D16-7838-78385	ISOLATOR	STANGER	HCB	20002838	1/01/1972	8
H004-D16-7838-78386	ISOLATOR	STANGER	HCB	20002837	1/01/1972	8
H004-D16-7838-7838SAA	SURGE ARRESTOR (GAPLESS)	BOWTHORPE EMP	3HSRCP96L27E27M3-22	20049405	28/09/2005	3
H004-D16-7838-7838SAB	SURGE ARRESTOR (GAPLESS)	BOWTHORPE EMP	3HSRCP96L27E27M3-22	20049406	28/09/2005	3
H004-D16-7838-7838SAC	SURGE ARRESTOR (GAPLESS)	BOWTHORPE EMP	3HSRCP96L27E27M3-22	20049407	28/09/2005	3

All equipment within the bay except for the bus disconnectors is just over 20 years old with an adequate rating (1,600A, 40kA). ABB CB has SF6 leak most likely form the gauge and its polymer housing is brittle and requires repair.

The HCB Stanger bus disconnectors are approaching 55 years old and their fault current rating, although still sufficient, can potentially be an impediment to the network configuration flexibility. Additionally, records show corrosion to tie rod ends and operating arms.

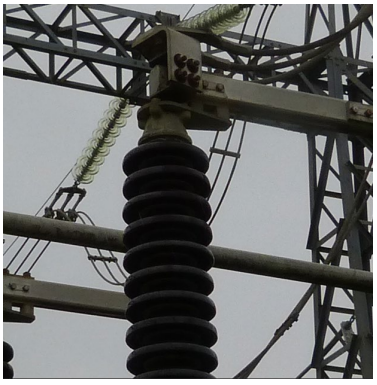


Figure 22- Photo of Equipment

Further, there are many notes of the isolator being extremely difficult to operate between 2015 and the last entry in 2023.

Recommendation:
Based on the above observations, it is recommended to replace both HCB Stanger bus disconnectors in this bay in the next 5 years along with structures and foundation.

2.2.10 110kV 3-4 Coupler Bay (D17)

The equipment within this bay is listed below.

Table 21- H004-D17-401

Functional Loc.	Description	Manufacturer	Equipment Number	Model number	Start-up date	CA HI
H004-D17-401--3BUSCTA	CURRENT TRANSFORMER	TRENCH	20087964	TAG145	18/03/2017	2
H004-D17-401--3BUSCTB	CURRENT TRANSFORMER	TRENCH	20087965	TAG145	18/03/2017	2
H004-D17-401--3BUSCTC	CURRENT TRANSFORMER	TRENCH	20087966	TAG145	18/03/2017	2
H004-D17-401--4012	CIRCUIT BREAKER	SPRECHER ENERGIE AUS	20002731	HGF312 3PAR P	12/12/1990	8
H004-D17-401--4015	ISOLATOR	STANGER	20002825	HCB	1/01/1972	7
H004-D17-401--4016	ISOLATOR	STANGER	20002824	HCB	1/01/1972	7
H004-D17-401--4BUSCTA	CURRENT TRANSFORMER	TRENCH	20087967	TAG145	18/03/2017	2
H004-D17-401--4BUSCTB	CURRENT TRANSFORMER	TRENCH	20087968	TAG145	18/03/2017	2
H004-D17-401--4BUSCTC	CURRENT TRANSFORMER	TRENCH	20087969	TAG145	18/03/2017	2

The current transformers in this bay were replaced in 2017. The CB in this bay is Sprecher circuit breaker f the same model; as CBs in bays D10 & D13 with similar condition issues. In addition, it has SF6 leak possibly from the gauge itself. Circuit breaker has history of a few chipped sheds, obscured sight glass and unreadable gauge. It is otherwise unproblematic.

The bus disconnectors have the same corrosion issues as those in D16 including corroded tie rod ends, and arm linkage rust.

Recommendation:
If failures in this bay are not of catastrophic nature, they will not hugely impact the network operations. It is recommended to consider enduring need for this bay before replacing the CB and disconnectors in this bay. If needed, then these will need to be replaced over next 5 years.,

2.2.11 110kV 1 Bus (KD1)

The equipment within this bay are listed below.

Table 22- H004-KD--KD1--

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up Date	CA HI
H004-KD--KD1--1BUSSAA	SURGE ARRESTOR (GAPLESS)	BOWTHORPE EMP	3HSRCP96L27E27M3-22	20054900	5/05/2007	4
H004-KD--KD1--1BUSSAB	SURGE ARRESTOR (GAPLESS)	BOWTHORPE EMP	3HSRCP96L27E27M3-22	20054901	5/05/2007	4
H004-KD--KD1--1BUSSAC	SURGE ARRESTOR (GAPLESS)	BOWTHORPE EMP	3HSRCP96L27E27M3-22	20054902	5/05/2007	4
H004-KD--KD1--4910	EARTH SWITCH	TAPLIN	110RCE/C817	20010213	1/01/1972	7
H004-KD--KD1--7VTA	ELECTROMAGNETIC VOLTAGE TRANSFORMER	TRENCH	0.2/3P SF6 POLY T6	20086868	21/10/2016	2
H004-KD--KD1--7VTB	ELECTROMAGNETIC VOLTAGE TRANSFORMER	TRENCH	0.2/3P SF6 POLY T6	20086869	21/10/2016	2
H004-KD--KD1--7VTC	ELECTROMAGNETIC VOLTAGE TRANSFORMER	TRENCH	0.2/3P SF6 POLY T6	20086870	21/10/2016	2

The equipment in this bay are in good condition except for Taplin earth switch. This is an integral part of disconnector 4117 located in Bay D13. It suffers from age related deterioration, hot spots and corrosion. It also has history of high resistance which required maintenance. Its rating is close to the actual calculated fault level at this site and may become a limitation.

Recommendation: Based on the above observation it is recommended to replace the Taplin earth switch along with the recommendations in Bay D13 and the brown post insulators used as bus supports along with associated structures and foundation.

2.2.12 110kV 2 Bus (KD2)

The equipment within this bay are listed below.

Table 23- H004-KD--KD2

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up date	CA HII
H004-KD--KD2--4920-1	EARTH SWITCH	ABB	ES145	20002809	6/02/1995	6

H004-KD--KD2--8VTA	ELECTROMAGNETIC VOLTAGE TRANSFORMER	TRENCH	0.2/3P SF6 POLY T6	20086865	27/09/2016	2
H004-KD--KD2--8VTB	ELECTROMAGNETIC VOLTAGE TRANSFORMER	TRENCH	0.2/3P SF6 POLY T6	20086866	27/09/2016	3
H004-KD--KD2--8VTC	ELECTROMAGNETIC VOLTAGE TRANSFORMER	TRENCH	0.2/3P SF6 POLY T6	20086867	27/09/2016	2

The earth switch is an integral part of 4127 Taplin disconnector (located in D13) which has been bridged. The earth switch was then taken out of service.

Trench voltage transformers were replaced in 2016 along with 1 Bus CVTs.

Recommendation:

This earth switch needs to be operational as it is the only earth switch enabling bus 2 and a part of Bus 4 to be earthed. The situation requiring this are very rare so some condition issues can be tolerated. Replace brown segmented post insulators in 5 years.

2.2.13 110kV 3 Bus (KD3)

The equipment within this bay is listed below.

Table 24- H004-KD--KD3

Functional Loc.	Description	Manufacturer	Model number	Equipment Number	Start-up date	CA HI
H004-KD--KD3—4930	EARTH SWITCH	TAPLIN	110RCE/C 817	20010215	1/01/1972	7
H004-KD--KD3--5VTA	ELECTROMAGNETIC VOLTAGE TRANSFORMER	TRENCH	TVG 123	20087061	22/11/2016	2
H004-KD--KD3--5VTB	ELECTROMAGNETIC VOLTAGE TRANSFORMER	TRENCH	TVG 123	20087062	22/11/2016	2
H004-KD--KD3--5VTC	ELECTROMAGNETIC VOLTAGE TRANSFORMER	TRENCH	TVG 123	20087063	22/11/2016	2

Taplin earth switch is over 50 years old and has exceeded it's expected reliable service life. It is integral part of isolator 4118 in Bay D13..

Trench voltage transformers were replaced in 2016 after history of paint peeling and corrosion which was difficult to stop the spread of. Since replacement, there have been no issues noted. Remaining reliable service life is 30 – 40 years.

Recommendation:
Based on the above observation it is recommended to replace the Taplin earth switch along with the recommendations for replacement of disconnector in Bay D13. Replace brown post insulators which are segmented.

2.3 Site Infrastructure

2.3.1 AC supply

There are two local supply sources for Mudgeeraba substation, one 33 kV connection originating from Energex owned substation T14 Burleigh and T91 Molendinar feeding two 33/0.415 kV 300 kVA station supply transformers. The preference would be to have local supply sourced from power transformer tertiaries.

In the future, with the power transformer replacement, allowance should be made to allow for AC supplies to come from the transformer tertiary.

Disel generator his location has been recently replaced (in 2017). Additionally, AC switch board has also been replaced.

2.3.2 Security Fence

The substation security fence has been replaced, with the removal of the original 2.44m chain wire fence and installation of new 3m high fencing, that meets design standard requirements. During site inspection, perimeter fence appeared in good condition with no noted corrosion.

Fence around the No.3 110 kV capacitor bank showed some corrosion on many posts either at the interface of the steel and concrete or at the platform level. Given this capacitor bank has been decommissioned this is not of concern.

No. 2 110kV capacitor bank fence in satisfactory condition, with light corrosion to few fence posts.

No.4 275kV capacitor bank fence could not be observed due to RAZ.

2.3.3 Site Drainage System

Drainage was not inspected in detail during 2025 site visit. Previous CA noted the swale drain was failing to completely drain resulting in water pooling in the drainage path. Recommended rectification works would include lowering the drain profile on the Northern end of the drain to develop a uniform fall along the entire drain (this will include work outside of the Substation fence).
It was recommended to improve drainage systems by clearing the culvert under the main substation access road and by realigning the two swale drains, firstly near Capacitor Bank 3 (to East of Substation) and secondly along the Western fence line on the outside of the permitter security fence; To ensure the water pooling does not contribute to the corrosion rate of hold down bolts and other installations at this site, a full drainage design system review needs to be undertaken and drainage system re-designed and improved.

Figure 23 - Site Drainage

2.3.4 Cable Trenches

A thorough assessment was unable to be performed of the cable trenches due to all cable trench covers being bolted shut on the cable pits. However, from the surface and from what was visible from the cable pulling pits the trenches appeared to be in good condition. They may have limited available space.

It is noted that a few of the cable pulling pits in front of the marshalling kiosk ware made from asbestos material and could easily be replaced, as mentioned above.

2.3.5 Yard Lights

Yard lights are in good condition and have been replaced. The cabling needs to be checked and tested, but it is likely their estimated remaining service life is 10 -15 years.

2.3.6 Strain Beams Hardware

There are some older glass insulators in 110 kV yar which should be inspected for pin corrosion and replaced as required.

2.4 Control Buildings/Workshop

There are three buildings on site. One is older brick building, and other two (control building for 100 kV and control building for 275 kV) are much newer demountable building.

Vehicle access to the brick building is currently restricted due to the presence of bollards on the road near D20 and D21. The first gate is the only way to safely approach the building. This limitation poses a significant constraint on the accessibility of the substation, particularly for maintenance and emergency response activities. It is essential to consider this access issue when planning any future works or emergency procedures at the substation.

All other aspects of the brick control building (including Workshop) are in an excellent condition including brick work, foundation, walls and roof cladding, floorboards and amenities. It is reasonable to expect that the brick control building will remain in a serviceable state for another 30 years.
There is asbestos register on site.
All asbestos containing material has been examined to be in a good condition with no cracks or significant exposure risk identified throughout the substation. The risk of exposure to asbestos fibres from the continued service of these items is presently considered low. The processes of any future works involving the removal/demolition works of the control building or cable pull pits needs to be carefully examined prior to the commencement of any works in order to mitigate the risk of exposure to airborne fibres that may be released during these works.
The demountable building No.10 (110 kV) was installed in 2017 when secondary systems were replaced.
The demountable building No.11 (275 kV) was installed in 2022 when secondary systems were replaced.

3. ASSET CONDITION ASSESSMENT OVERVIEW

Table 25- Overview of condition assessment recommendations

Asset	Asset Replc. Recom. (Y/N)	Recom. Replc. timing (yrs)	Refurb. Recom. (Y/N)	Corr. Maint. Rec. (Y/N)	Recommendations
C01 - 501	N	20	N	N	
C01 - 541	Y		N	N	Replace CTs & SA and Ruhrtal isolator and earth switches
C02 - 502	N	20	N	N	
C02 - 597					Remove CB from site. This is spare bay.
C02 - 835	N	15	N	N	
C03 -503	N	15	N	N	
C03 - 545	Y		N	N	Replace CB and Alstom DES/ESWs in 5 years
C03 - 836	N	15	Y	N	Investigate refurbishment options for AEM disconnectors and replace IMB300 CTs (included in the separate project already
C51 -4 Cap	Y		N	N	Replace IMB300 CTs (included in the separate project already)
D05 (F706)	Y		Y	N	Replace CB and Disconnectors in 5 years..

D06 (2 Cap)	Y		N	N	Replace Low_Bonar Stanger CTs in 5 years and replace reminder of the bay in 10 years with cap bank.
D07 (F779)	Y		Y	N	Replace or refurbish Taplin disconnectors in 5years.
D08 (F780)	Y		N	N	Replace two Taplin disconnectors in 5years.
D09 (1 Spare)	Y		N	N	Replace segmented insulators
D10 (1 TX)	Y		N	N	Replace CB and CT in 5 years
D13 411 (1-3 Bus Section)	Y		Y	N	Replace whole bay in 5 years
D13 412 (1-4 Bus Section)	Y		N	N	Replace disconnectors with bus support insulators.
D16 (F838)	Y		N	N	Replace disconnectors in 5 years.
D17 (3-4 Bus Coupler)	Y		N	N	Replace CB and disconnectors in 5 years.
KD1 (1 Bus)	Y		N	N	Replace ES and brown post insulators in 5 years.
KD2 (2 Bus)	Y	5-Oct	Y	N	Replace brown post insulators in 5 years.
KD3 (3 Bus)	Y	5-Oct	Y	N	Replace ES and brown post insulators in 5 years.
BUILDINGS	N	40	N	N	
AC SUPPLY	N	20	N	N	
Strain Beams Hardware	Y		N	N	replace glass insulators.

4. APPENDICES

This report needs to be viewed in conjunction with

- Condition assessment report (2007)
    - Complete condition assessment report
- Supplementary condition assessment report (2011)
    - Foundations, structure and drainage only
- Transformer condition assessment report (2012)
    - T2 and T3 power transformers only

4.1 Reference information

- *Appendix No.1 :*
  Civil condition assessment report Objective Id zA122061

H004 Mudgeeraba Civil Condition Assessment May 2014.obr

- *Appendix No.2:*
  Site Asbestos Register Objective Id A2000458

ASB-REG-H004 Site Asbestos Register for Mudgeeraba.obr

- *Appendix No.3:*
  Final report for 2T refurbishment Objective Id A2001353

T2 Mudgeeraba Substation - Final Report.obr

- *Appendix No.4:*
  Final report for 3T refurbishment Objective Id A2001354

Eng Report - T3 Mudgeeraba.obr

4.2 Replacement Index Methodology

Replacement index for bays and other substation assets is based on the condition of the equipment in the bay, condition of structures and foundations (all being assigned health index as condition indicator), ay voltage level and type, bay location criticality and bay compliance with legislation and standards. It provides an indication of the remaining life based on its condition and criticality, rather than based on it time in service.

Table 26- RI Methodology Overview

RI	Estimated Remaining Life(yrs)	Action	Comment	Comment
10	1 -2	condition assessment (CA) required on annual basis (or special maintenance regime)	project scoped and approved, included in the current Reset period	**Poor condition needs urgent action.**
9	2-3	CA required on annual basis (or special maintenance regime)	project scoped and in final approval stages, included in the current Reset period	Poor condition, needs prompt, planned action.
8	3 - 5	CA required on annual basis (or special maintenance regime)	project scoping, options analysis	
7	5 - 10	high level project scoped	high level project scoped for regulator, CA done	
6	10 - 20	CA trigger	CA to be done within 1 year and ready for next Reset, scope project before next Reset	Deteriorating condition, future replacement required, but in a planned fashion.
5	20 - 25	plan CA in 5 yrs		Aged satisfactory condition.
4	25 - 30	mid life CA (desktop)	Desktop assessment of notified issues	Needs some replacements, typically only few, minor components
3	30 - 35	annual review of HI and RI begins	aging - good condition	
2	35-40	good condition, annual review of notifications, dealing with infant mortality issues		
1	≥40	New		

Planning Report	28 August 2025
Title	CP.03208 - Mudgeeraba Selective Primary Plant Replacement
Zone	Gold Coast
Need Driver	Emerging safety and compliance risks arising from condition of ageing 275kV and 110kV primary plant equipment.
Network Limitations and statutory requirements	Mudgeeraba Substation is required to meet Powerlink Queensland's N-1-50MW/600MWh Transmission Authority reliability standards and maintain power transfer capability to the Gold Coast and to northern NSW via the Directlink HVDC interconnector.
Pre-requisites	None

Executive Summary

Mudgeeraba and Molendinar substations provide power supply to the for the Gold Coast zone and Northern NSW via the Directlink HVDC interconnector.

Mudgeeraba Substation was built in 1972. Some equipment is original and will be in service for 54 years by 2026. Condition assessment shows deterioration and there is significant safety and network risk associated with the equipment failing.

Powerlink's 2025 Central scenario forecast confirms there is an enduring need to maintain electricity supply to the loads supplied from Mudgeeraba Substation. The removal or reconfiguration of the Mudgeeraba's 275/110kV Substation due to primary plant failure would violate Powerlink's N-1-50MW/600MWh Transmission Authority reliability standard and significantly impact the power transfer capability into the Gold Coast and to northern NSW via the Directlink HVDC interconnector.

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

Table of Contents

1. Introduction

H004 Mudgeeraba Substation is located approximately 10km north of the Queensland-NSW border and is a major injection point into the Gold Coast area. It is also the primary hub supplying Essential Energy's Terranora Substation and power to northern NSW via the Directlink HVDC interconnector.

Mudgeeraba Substation was initially established in 1972 as a 110kV switchyard and expanded circa 1997 by the establishment of the 275kV switchyard that is supplied from Greenbank via two 275kV single circuits to a fully switchable 275kV switchyard comprising two 275/110kV transformers.

The 110kV network from Molendinar to Mudgeeraba links the coastal bulk supply points at Southport, Surfers Paradise and Broadbeach via an underground cable network and an inland overhead 110kV network supplies Robina and Nerang substations. This network is owned and operated by Energy Queensland.

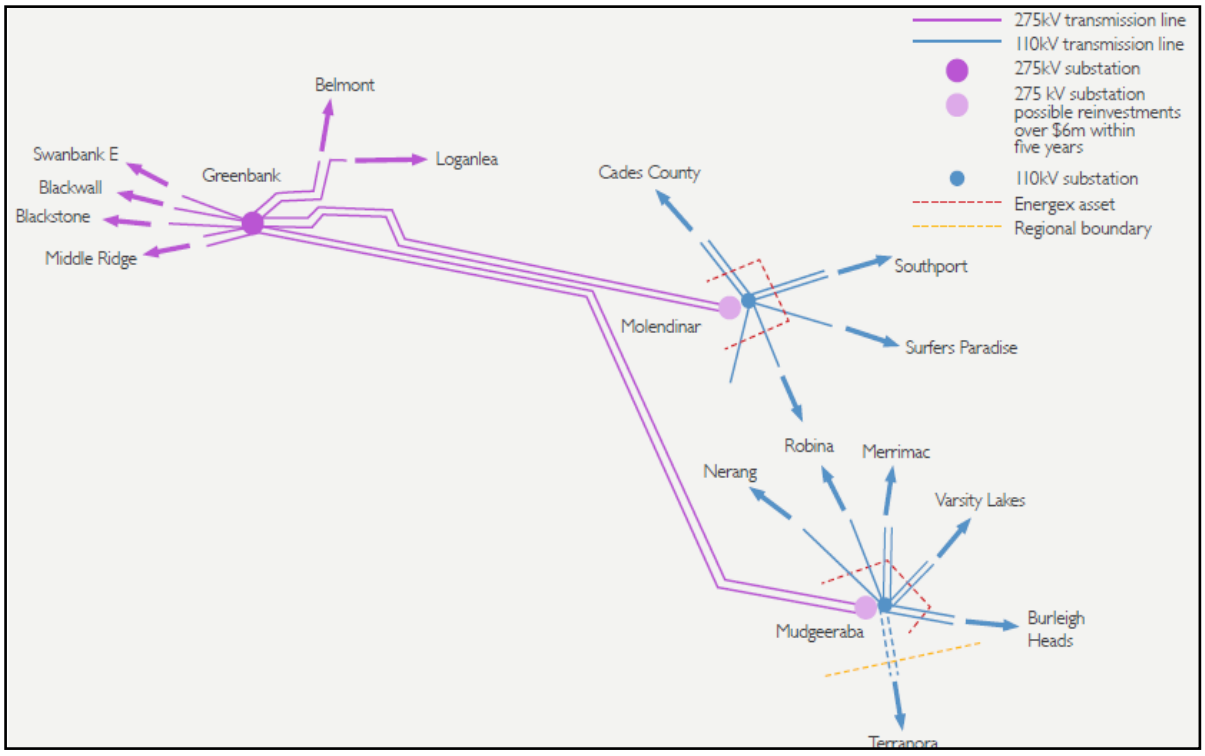


Figure 1. Mudgeeraba Substation – Gold Coast

The condition assessment, detailed in “Mudgeeraba Substation H004 Condition Assessment Report 2025” [1], has concluded that many of the original assets are reaching the end of their operational life and recommends that action is taken to address network and safety risks arising from the condition of the ageing plant.

The condition assessment report recommends that the primary plant at risk of failure should be replaced within the next 5 years (at latest 2030). This report assesses the impact that removal of the at-risk primary 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 Mudgeeraba Substation.

2. H004 Mudgeeraba Substation configuration

Figure 2 shows the existing connection configuration of the Mudgeeraba Substation, highlighting the primary plant reaching end of life.

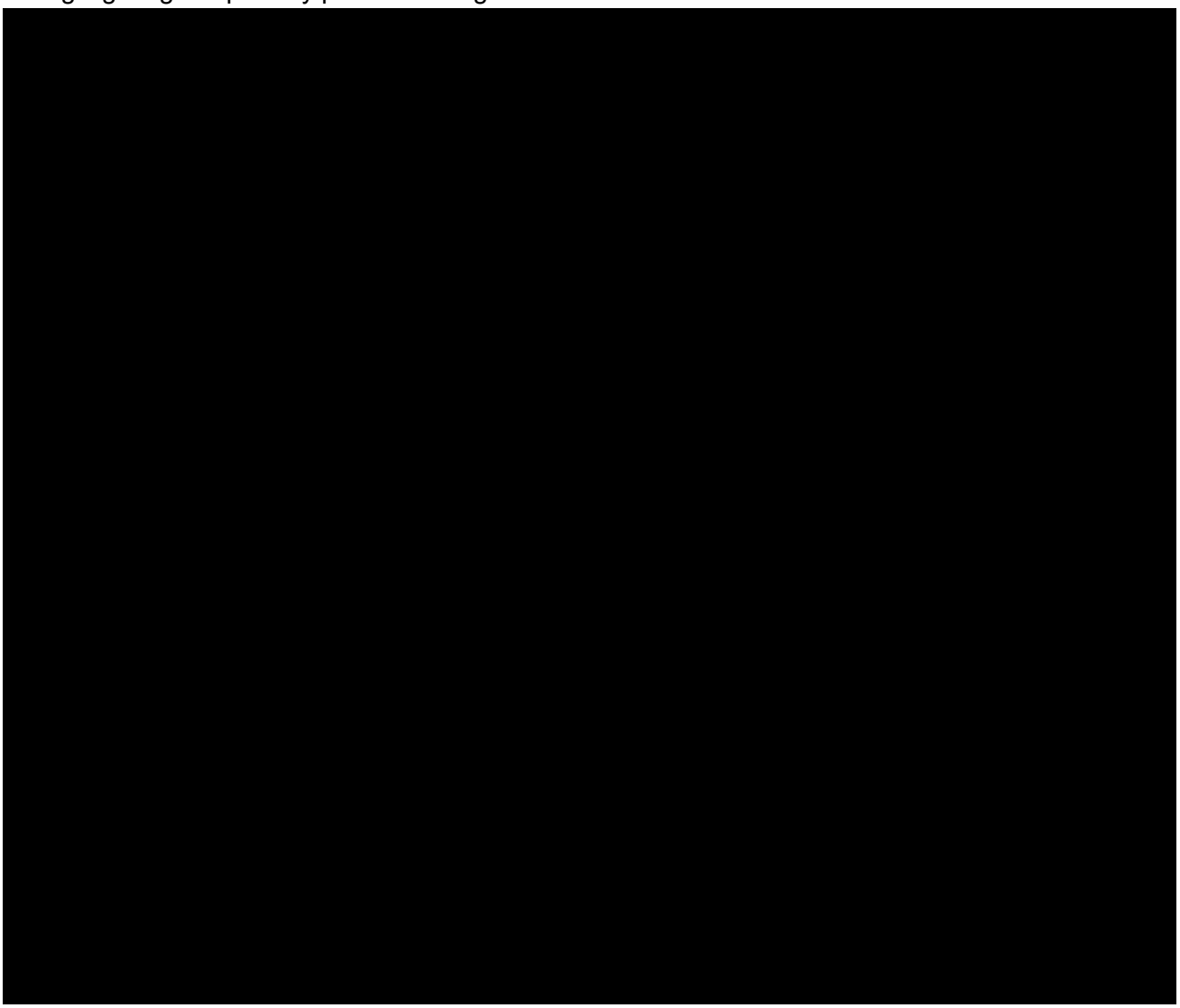


Figure 2 – Mudgeeraba 275/110kV Substation Line Dagram

3. Gold Coast zone Demand Forecast

Figure 3 shows that the maximum demand for the Gold Coast loads (connected to Mudgeeraba and Molendinar) are forecasted to experience continuous growth in the coming years.

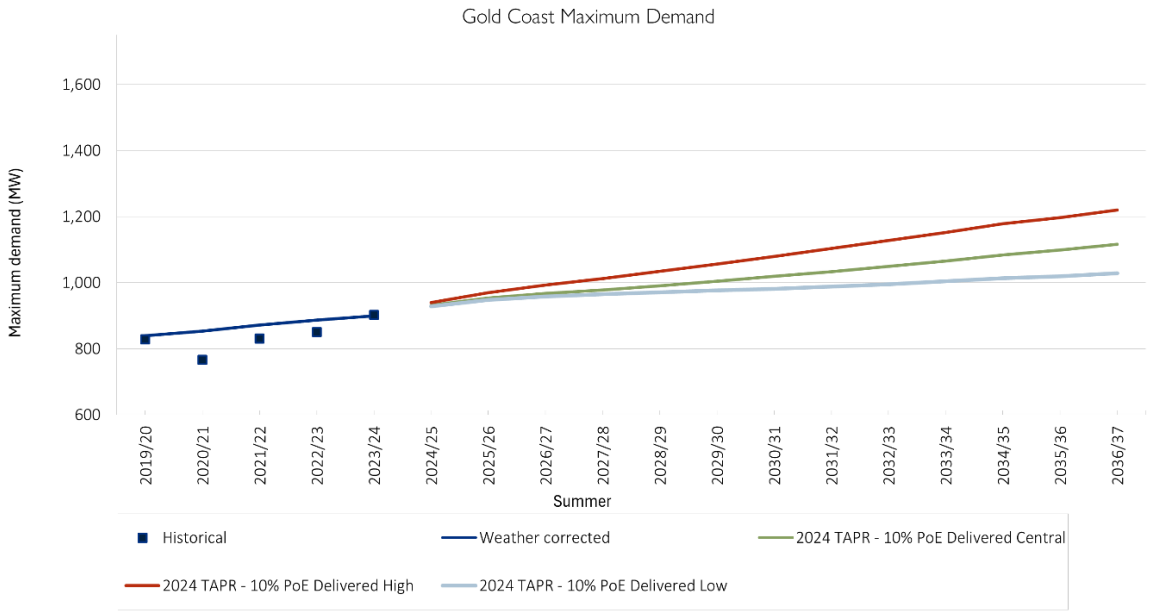


Figure 3. Gold Coast zone Maximum Demand

With consideration of rooftop PV within the Energex network supplied from Molendinar and Mudgeeraba substations, the maximum customer load is significantly higher. Figure 4 shows that rooftop PV meets up to 400MW of underlying demand.

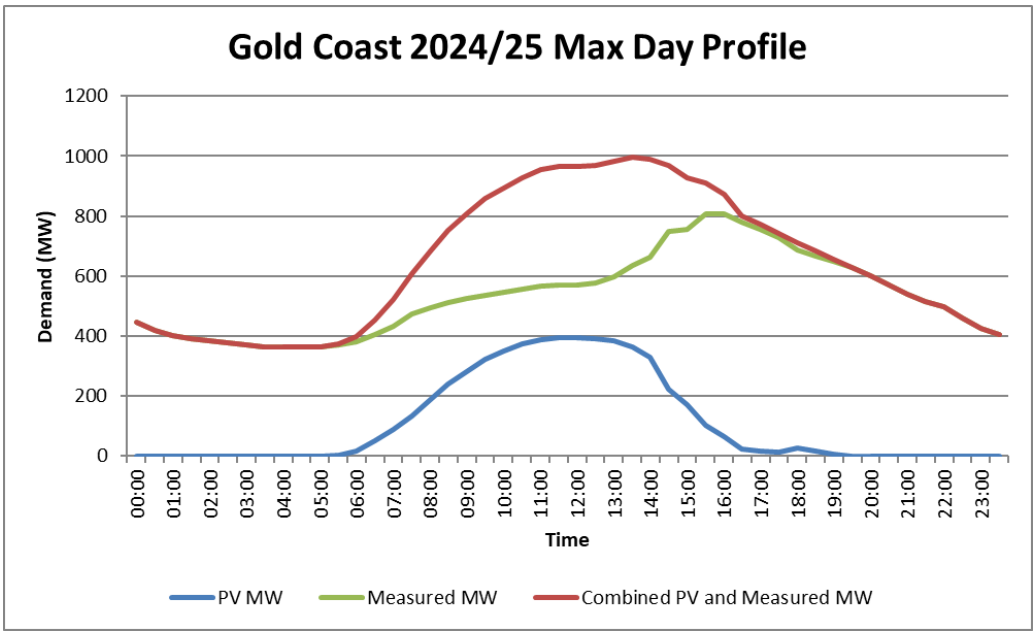


Figure 4. Gold Coast Max Day Profile 2024/25

Figure 5, shows the historical load duration curve of the Gold Coast zone with the contribution of rooftop PV excluded.

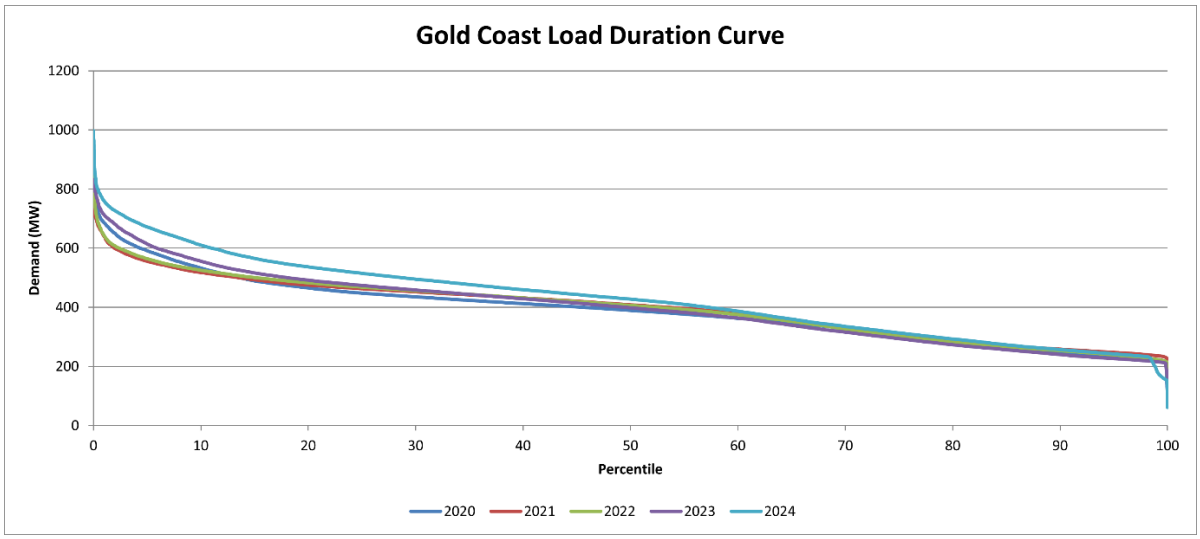


Figure 5. Gold Coast 110kV Load Duration Curve (rooftop PV out-of-service)

Figure 6, shows the comparative load duration curve for the delivered demand (i.e. with the contribution from the rooftop PV included).

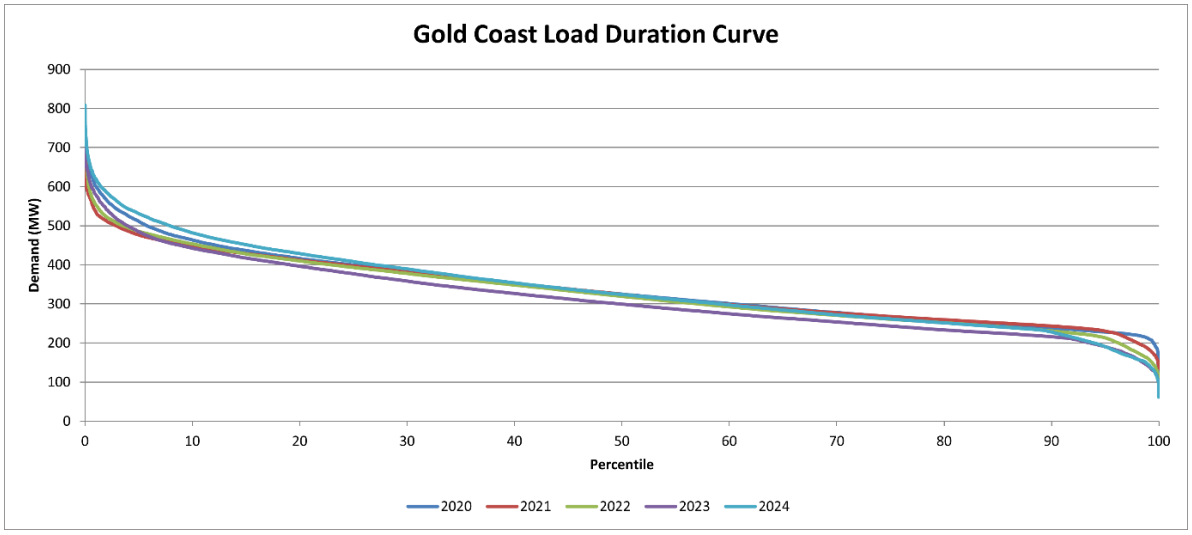


Figure 6. Gold Coast zone Load (rooftop PV in-service)

There are no new large block loads committed in the Gold Coast zone for the Central scenario forecast. However, there is an existing load that is investigating a potential 20MVA increase in its maximum demand within the forecast period. This is not yet committed but would be supplied from Varsity Lakes and Terranora.

4. Statement of Investment Need

As outlined in the Section 2, the Mudgeeraba Substation is a major bulk supply point for Energex (Energy Queensland) loads in the Gold Coast zone. The failure to replace at-risk primary plant at the substation would have a major impact on the performance of this network and the reliability of supply to associated loads, which would ultimately result in loss of load exceeding Powerlink's N-1-50MW / 600MWh Transmission Authority reliability standard. There would also be impacts on the capability to transfer power to northern NSW via the Directlink HVDC interconnector.

Selected primary plant replacement (refer to Table 1) is necessary to maintain Powerlink's N-1-50MW/600MWh Transmission Authority reliability standard.

Ref	Functional Location	Primary Plant	Network Impacted
	H004-C02-597--5972	CIRCUIT BREAKER	No impact (bypassed)
	H004-C02-835--8352	CIRCUIT BREAKER	No Impact
	H004-C03-545--5452	CIRCUIT BREAKER	No Impact
1	H004-D05-706--7062	CIRCUIT BREAKER	Nerang at Risk (798)
1	H004-D05-706--7061	DISCONNECTOR	Nerang at Risk (798)
1	H004-D05-706--7065	DISCONNECTOR	Nerang at Risk (798) during repair of isolator
1	H004-D05-706--7066	DISCONNECTOR	Nerang at Risk (798) during repair of isolator
	H004-D06-482--4822	CIRCUIT BREAKER	50MVA capacitor bank
	H004-D06-482--4822CTA	CT	50MVA capacitor bank
	H004-D06-482--4822CTB	CT	50MVA capacitor bank
	H004-D06-482--4822CTC	CT	50MVA capacitor bank
	H004-D06-482--4821	DISCONNECTOR	50MVA capacitor bank
	H004-D06-482--4823	DISCONNECTOR	50MVA capacitor bank
2	H004-D10-441--4412	CIRCUIT BREAKER	1T 275/110kV outage – 5T contingency
2	H004-D10-441--4412CTA	CT	1T 275/110kV outage – 5T contingency
2	H004-D10-441--4412CTB	CT	1T 275/110kV outage – 5T contingency
2	H004-D10-441--4412CTC	CT	1T 275/110kV outage – 5T contingency
	H004-D13-411--4112	CIRCUIT BREAKER	Bus section CB – no impact for N-1-1 assuming plant connected to 1 Bus is switched to 2 Bus
	H004-D13-411--1BUSCTA	CT	no impact for N-1-1 assuming plant connected to 1 Bus is switched to 2 Bus
	H004-D13-411--1BUSCTB	CT	no impact for N-1-1 assuming plant connected to 1 Bus is switched to 2 Bus
	H004-D13-411--1BUSCTC	CT	no impact for N-1-1 assuming plant connected to 1 Bus is switched to 2 Bus
	H004-D13-411--3BUSCTA	CT	no impact for N-1-1 assuming plant connected to 3 Bus is switched to 4 Bus

	H004-D13-411--3BUSCTB	CT	no impact for N-1-1 assuming plant connected to 3 Bus is switched to 4 Bus
	H004-D13-411--3BUSCTC	CT	no impact for N-1-1 assuming plant connected to 3 Bus is switched to 4 Bus
	H004-D13-411--4117	DISCONNECTOR	no impact for N-1-1 assuming plant connected to 1 Bus is switched to 2 Bus
	H004-D13-411--4118	DISCONNECTOR	no impact for N-1-1 assuming plant connected to 3 Bus is switched to 4 Bus
	H004-D13-412--4127	DISCONNECTOR	Decommission the isolator and connect bus
	H004-D13-412--4128	DISCONNECTOR	Decommission the isolator and connect bus
	H004-D17-401--4012	CIRCUIT BREAKER	3 Bus 4 Bus coupler no impact for N-1-1 assuming plant connected to 1 Bus and 3 Bus or 2 Bus and 4 Bus
	H004-D17-401--4015	DISCONNECTOR	3 Bus 4 Bus coupler no impact for N-1-1 assuming plant connected to 1 Bus and 3 Bus or 2 Bus and 4 Bus
	H004-D17-401--4016	DISCONNECTOR	3 Bus 4 Bus coupler no impact for N-1-1 assuming plant connected to 1 Bus and 3 Bus or 2 Bus and 4 Bus
2	H004-C01-541--1TRFCTA	CT	1T 275/110kV outage – 5T contingency
2	H004-C01-541--1TRFCTC	CT	1T 275/110kV outage – 5T contingency
	H004-M02-2CAP-2CAPCTA	CT	50MVA capacitor bank
	H004-M02-2CAP-2CAPCTB	CT	50MVA capacitor bank
	H004-M02-2CAP-2CAPCTC	CT	50MVA capacitor bank
3	H004-D04-794--20VTA	CVT	Robina at Risk (7229)
3	H004-D04-794--20VTB	CVT	Robina at Risk (7229)
3	H004-D04-794--20VTC	CVT	Robina at Risk (7229)
4	H004-D16-7838-18VTA	CVT	Varsity lakes at Risk (839)
4	H004-D16-7838-18VTB	CVT	Varsity lakes at Risk (839)
4	H004-D16-7838-18VTC	CVT	Varsity lakes at Risk (839)

5	H004-D21-757--16VTA	CVT	Terranora at Risk (758)
5	H004-D21-757--16VTC	CVT	Terranora at Risk (758)
4	H004-D22-7839-19VTA	CVT	Varsity lakes at Risk (838)
4	H004-D22-7839-19VTB	CVT	Varsity lakes at Risk (838)
4	H004-D22-7839-19VTC	CVT	Varsity lakes at Risk (838)
6	H004-D07-779--7795	DISCONNECTOR	Merrimac + ? at Risk (780) during repair of isolator
6	H004-D07-779--7796	DISCONNECTOR	Merrimac + ? at Risk (780) during repair of isolator
6	H004-D08-780--7805	DISCONNECTOR	Merrimac + ? at Risk (779) during repair of isolator
6	H004-D08-780--7806	DISCONNECTOR	Merrimac + ? at Risk (779) during repair of isolator
	H004-D09-491--4915	DISCONNECTOR	Decommission bay = D09
	H004-D09-491--4916	DISCONNECTOR	
4	H004-D16-7838-78385	DISCONNECTOR	Varsity Lakes at risk (839) during repair of isolator
4	H004-D16-7838-78386	DISCONNECTOR	Varsity Lakes at risk (839) during repair of isolator

5. Network Risk

Table 1 defines the maximum and average forecast load supplied from the 110kV at Mudgeeraba (including Terranora) for summer 2032/33. The underlying load values represent the actual customer load (i.e. exclude the contribution from rooftop PV).

Table 2 summarises the results of analysis to determine the load and energy at risk for loads connected to the Mudgeeraba Substation. The estimates account for the expected level of rooftop PV connected to the Energex network supplied from Mudgeeraba. This level of rooftop PV is discounted to capture the total level of customer load at risk of not being supplied.

The analysis assumes that long term outages will occur and therefore any possible load transfers would not be sustained. In determining the forecasted load for Terranora substation, it will also be assumed that the embedded generator (Condong) downstream from Terranora substation will not be able to support the load as it is a non-scheduled generator. Furthermore, as the Directlink HVDC interconnector requires an AC source on both ends to operate, loss of the power injection from Mudgeeraba to Terranora will result in the trip of the interconnector. Thus, in scenarios causing the loss of supply at Mudgeeraba, Terranora load will also be shed.

In the event of a Mudgeeraba 275/110kV transformer outage, the network is split such that the system is secure (refer to Appendix for network configuration). In doing so, load at Burleigh, Varsity Lakes, Merrimac, Terranora and local Mudgeeraba load will be at risk for the next contingency.

Table 1 – South Gold Coast and Terranora Load Summary

Measure	2032/33
Max Underlying Load (MW)	428
Avg Underlying Load (MW)	193
Max Delivered Load (MW)	342
Avg Delivered Load (MW)	126

Table 2 – South Gold Coast and Terranora 110kV Load at Risk

Ref	At Risk	Contingency	Metric	2033
2	Mudgeeraba, Burleigh, Varsity Lakes, Merrimac and Terranora	275/110kV transformers (1T & 5T) or 275kV Greenbank to Mudgeeraba feeders (835 & 836)	Max (MW)	487
			Average (MW)	193
			24h Energy Unserved Max (MWh)	7451
			24h Energy Unserved Average (MWh)	4622
5	Terranora 33kV	110kV Mudgeeraba to Terranora feeders (757 & 758)	Max (MW)	135
			Average (MW)	37
			24h Energy Unserved Max (MWh)	1849
			24h Energy Unserved Average (MWh)	893
4	Varsity Lakes 11kV	110kV Feeders to Varsity Lakes (F839 & F838)	Max (MW)	109
			Average (MW)	19
			24h Energy Unserved Max (MWh)	801
			24h Energy Unserved Average (MWh)	468
6	Merrimac	110kV Feeders to Merrimac (779 and 780)	Max (MW)	82
			Average (MW)	16
			24h Energy Unserved Max (MWh)	793
			24h Energy Unserved Average (MWh)	395
1	Nerang	110kV Feeders to Nerang (706 and 798)	Max (MW)	117
			Average (MW)	37
			24h Energy Unserved Max (MWh)	1503
			24h Energy Unserved Average (MWh)	879
3	Robina		Max (MW)	59
			Average (MW)	25

		110kV Feeders to Robina (794 and 7229)	24h Energy Unserved Max (MWh)	1225
			24h Energy Unserved Average (MWh)	596

6. Market Impact

The Directlink HVDC system connects Bungalora to Mullumbimby in Northern NSW (refer to Figure 5). Bungalora connects to Terranora at 110kV. As HVDC system requires AC supply at both ends to operate a double circuit outage between Mudgeeraba and Terranora results in its outage. This reduces the overall power transfer capability between Queensland and NSW.

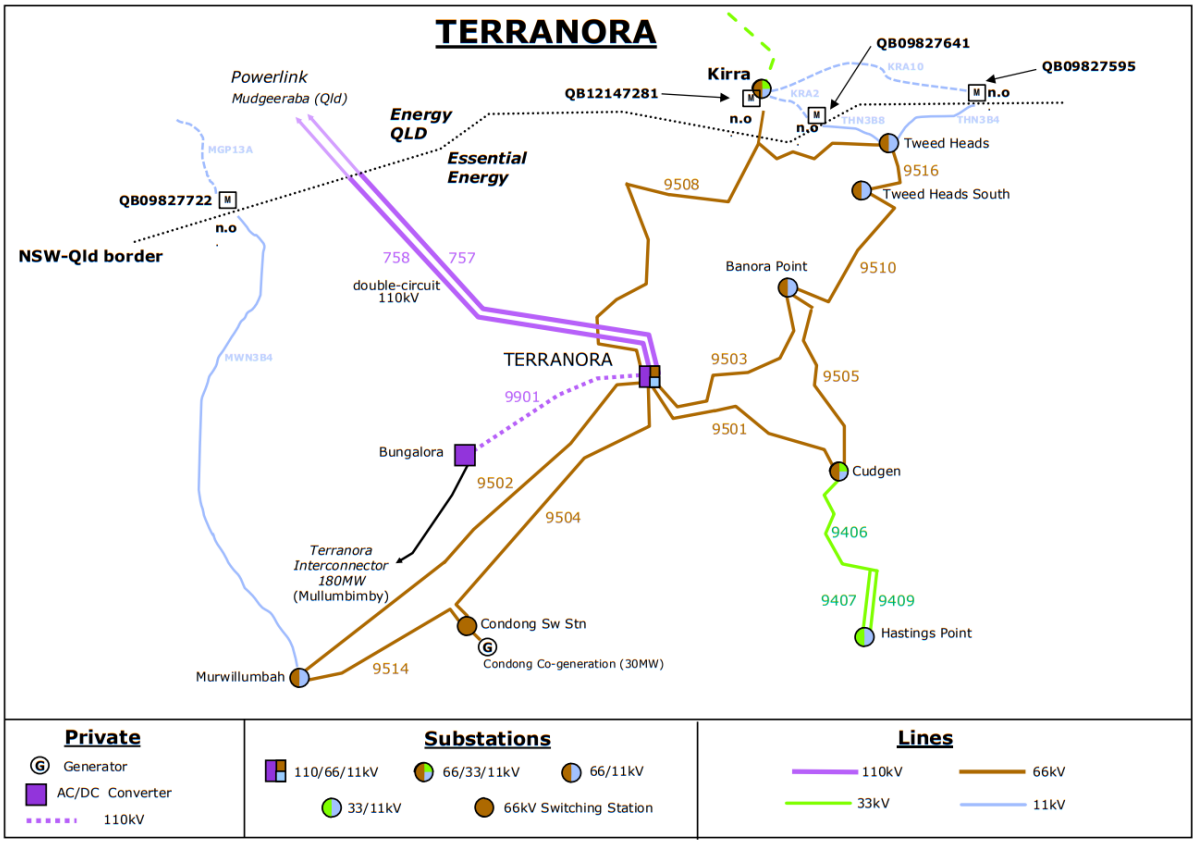


Figure 5. Northern NSW network

Table 2 defines the maximum and average difference in total system costs (including emissions) per 24-hour period with the HVDC system removed from service.

The methodology used to assess these market impacts is outlined in Appendix B.

Table 1. Market impact of removing constraining Directlink.

At Risk	Contingency	Metric	$M
Loss of Directlink HVDC system	110kV Feeders into Terranora (757 & 758)[1]	Max 24h incremental system cost ($m)	1.883
		Average 24h incremental system cost ($m)	0.173
Loss of Directlink HVDC system	275/110kV transformers (1T & 5T) or 275kV Greenbank to Mudgeeraba feeders (835 & 836)	Max 24h incremental system cost ($m)	1.883
		Average 24h incremental system cost ($m)	0.173

7. Non-Network Options

The Mudgeeraba Substation facilitates 275kV flow between Brisbane and the Gold Coast area. The substation hosts two 275/110kV transformers to facilitate supply to Energex loads in the southern area of the Gold Coast.

To meet the Mudgeeraba demand, the non-network solution must be capable of delivering up to 343 MW of power and 5441 MWh of energy each day. This allows for the contribution from rooftop PV.

Powerlink is not aware of any Demand Side Solutions (DSM) in the Gold Coast area supplied from Molendinar 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 prior to project approval.

8. Network Options

8.1 Proposed Option to address the identified need

It is recommended that the replacement of 275kV and 110kV primary plant reaching end of life at Mudgeeraba Substation is to be completed within the next 5 years (at latest 2030). This option ensures that all reliability of supply and asset condition criteria are met as well as maintaining the power transfer capability into the Gold Coast area.

Further details of condition assessment for the Mudgeeraba Substation secondary systems and their recommended replacement timing can be found in [1].

[1] For the outage of 110kV double circuit between Mudgeeraba and Terranora, the Directlink HVDC system would also trip as the HVDC system requires AC supply at both ends to operate. There is little to no transfer capability to transfer load off Terranora (~1MVA).

8.2 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.

8.2.1 Do Nothing

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

8.2.2 Decommission all ageing assets in Mudgeeraba substation

Under this option, it would be proposed that all aging primary plant is to be decommissioned. As discussed earlier in section 5, the decommissioning of ageing assets will result in loss of load and hence will breach Powerlink’s N-1-50MW/600MWh reliability obligations. As such, it is advised that this is not a viable option moving forward.

9. Recommendations

Powerlink has reviewed the condition of primary plant at H004 Mudgeeraba Substation and have detected that select plant are reaching the end of their technical service. It is therefore recommended that the plant is to be replaced.

Retaining the condition of primary plant at Mudgeeraba Substation will allow Powerlink to continue to meet its required reliability obligations (N-1-50MW/600MWh) and maintain the power transfer capability from Brisbane into the Gold Coast area.

10. References

1. Mudgeeraba Substation H004 Condition Assessment Report 2025
2. CP.03208 H004 Mudgeeraba Selective Primary Plant Replacement – Project Scope Report (Revenue Reset)
3. Transmission Annual Planning Report 2024
4. Asset Planning Criteria Framework

Appendix A – Network Risk methodology

Mudgeeraba 275/110kV Transformers

When the Gold Coast load exceeds approximately 550MW and one of the 275/110kV transformers at Mudgeeraba is out-of-service (T1 or T5), then the 110kV Energy Queensland network between Molendinar and Mudgeeraba must be opened to return the system to a secure state. The 110kV coastal lines between Broadbeach and Merrimac are to be opened alongside the inland 110kV overhead lines connecting to Mudgeeraba from Nerang and Robina. As a result, for the outage of the remaining 275/110kV transformer, the large load centres at Mudgeeraba, Varsity Lakes, Burleigh Heads, Merrimac and Terranora will be lost.

A non-network proponent would need to continuously (pre-contingent) reduce the Gold Coast load to less than 550MW to avoid the need to split.

Project Scope Report

CP.03208

H004 Mudgeeraba Replace Selective Primary Plant

Concept – Version 1

Document Control

Change Record

Issue Date	Revision	Prepared by	Reviewed by	Approved by	Background
6/06/25	1	[redacted]	[redacted]	[redacted]	

Related Documents

Issue Date	Responsible Person	Objective Document Name
23/04/2018	[redacted]	PIF_H004 Mudgeeraba Selective Primary Plant Replacement (A2893434)

Document Purpose

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

Project Contacts

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

Project Details

1. Project Need & Objective

H004 Mudgeeraba substation was built in 1972 and some of the equipment are original and will be in service for 54 years by 2026. Maintenance records show deterioration of the condition of some of these equipment. There is significant network risk associated with the equipment failing in service or during maintenance or periodic testing, possibly resulting in extended interruption to supply.

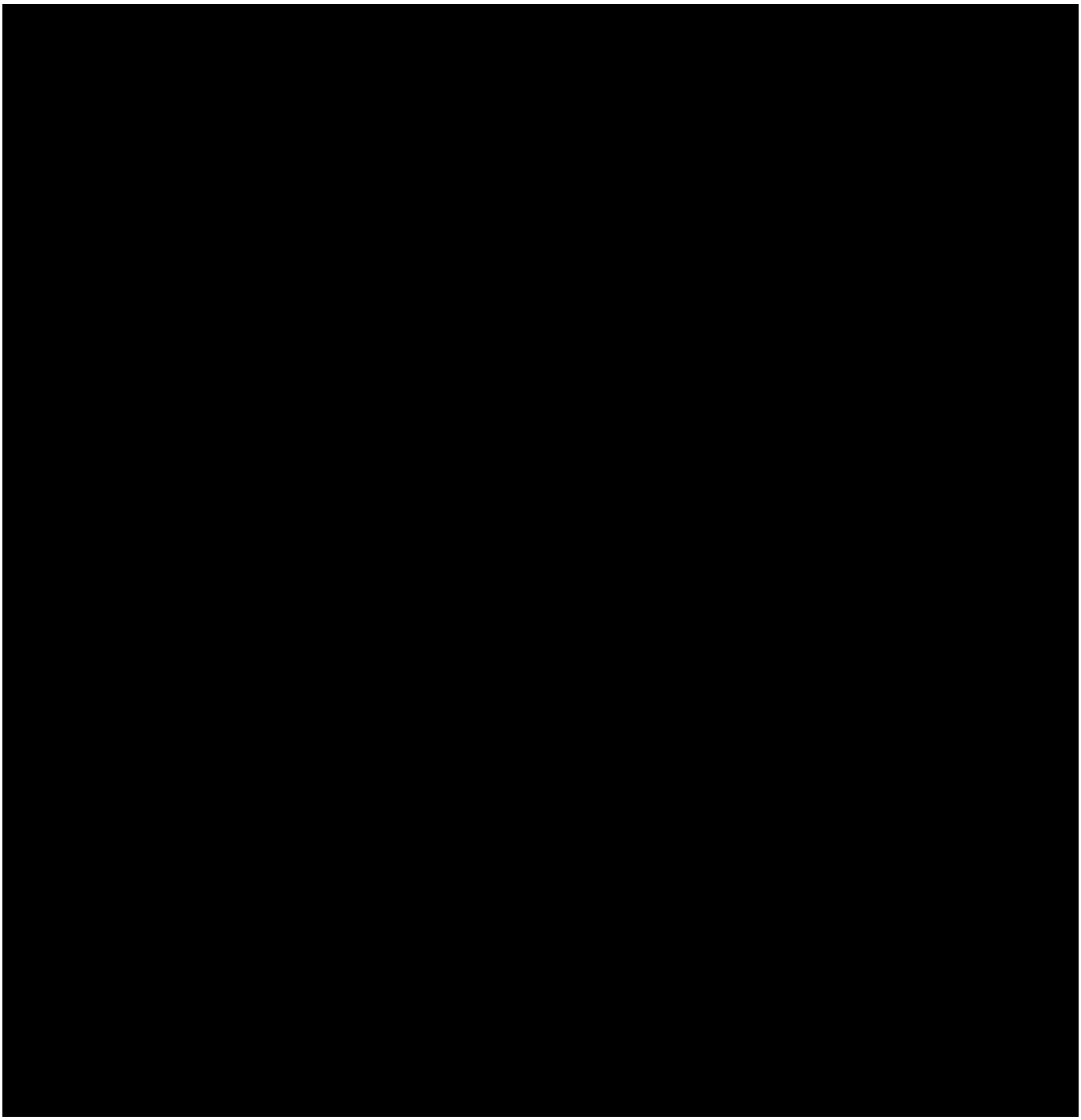
The objective of this project is to replace selected primary plant in H004 Mudgeeraba substation by June 2032.

This project will follow the two (2) stage approval process.

2. Project Drawing

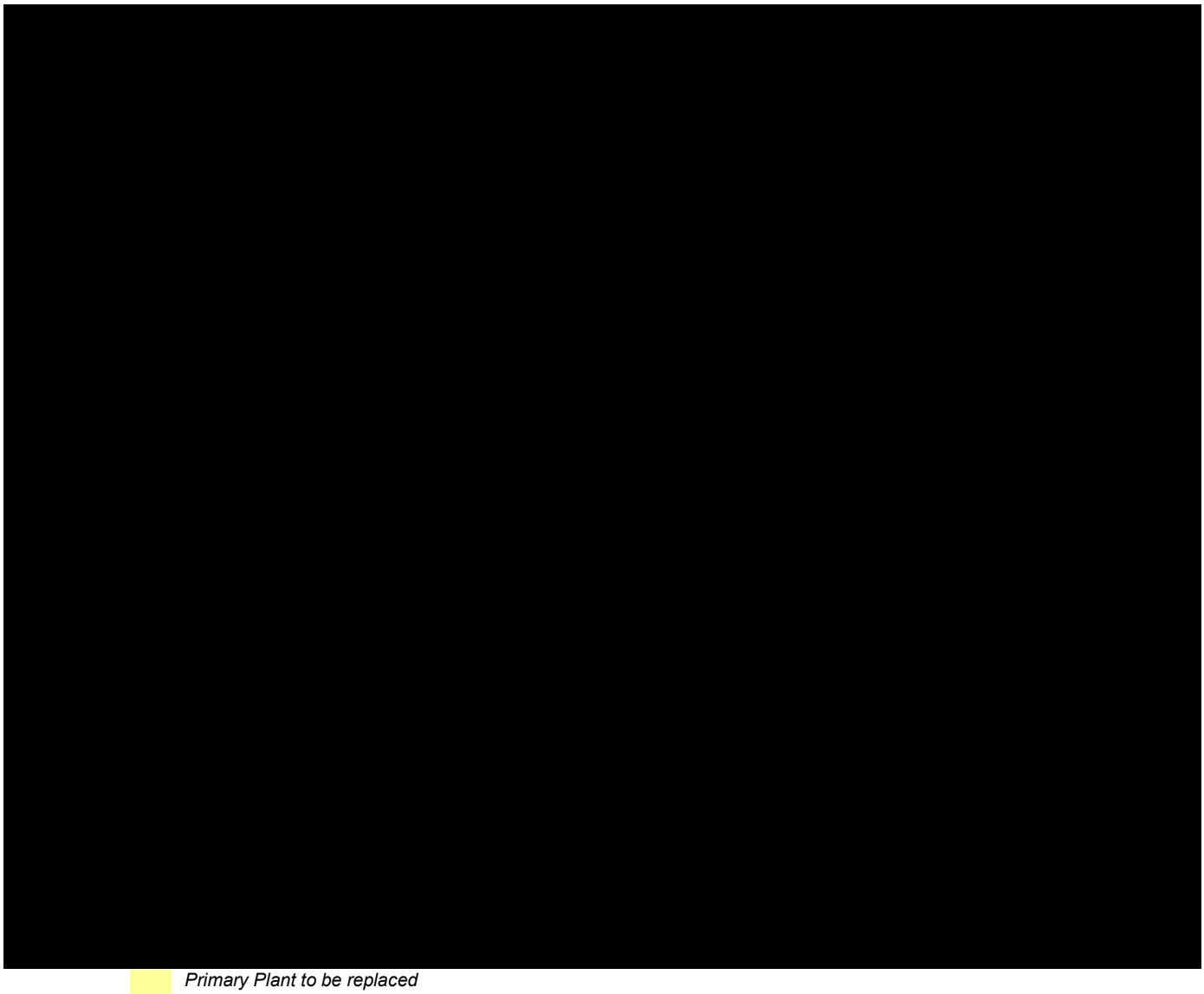
Primary plant to be replaced

Figure 1: Mudgeeraba 275kV Line Diagram (A1-H-119193-001)



Primary Plant to be replaced

Figure 2: Mudgeeraba 110kV Line Diagram (A1-H-119193-003)



Primary Plant to be replaced

Figure 3: Mudgeeraba 110kV Line Diagram (A1-H-119193-002)

Figure 4: Mudgeeraba 110kV Switchyard (Post insulator as marked need replacing)

3. Deliverables

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

This project will follow the two stage approval process. The following deliverables are to be provided for the purposes of options analysis as required under the RIT-T:

1. A report (e.g. Concept Estimate Report) detailing the works to be delivered, high level staging, resource requirements and availability, and outage requirements and constraints;
2. A class 5 estimate (minimum);
3. A basis of estimate document and risk table, detailing the key estimating assumptions and delivery risks; and
4. Outline staging and outage plans.

4. Project Scope

4.1. Original Scope

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

Briefly, the project consists of replacement of selected primary plants at Mudgeeraba substation.

4.1.1. Transmission Line Works

Not applicable

4.1.2. H004 Mudgeeraba Substation Works

Design, procure, construct and commission the replacement of the selected primary plant listed in Attachment 1, with consideration of the following:

- For bays requiring both CB and CT replacement, consideration should be given to utilising dead tank circuit breakers;
- Decommission 275kV bay =C02-Q20, =D09 (remove disconnectors) and =D13-Q20 (between Bus 2 and Bus 4 by removing bridged disconnectors and join Bus 2 and Bus 4;
- Modify the secondary systems as required to facilitate the primary plant replacement.
- Brown post insulators supporting Busbar in Diameters =D13, =D14, =D16 and =D17 (including post insulators between bus isolator and CB in diameter =D17) and in between =D13 and =D14, =D15 and =D16 and =D17 and =D18 shall be replaced as shown in Figure 4;

- Glass insulators on strung bus associated with diameters =D13, =D14, =D16 and =D17 shall be replaced as shown in Figure 4;
- Current transformers used for bus zone protection must be sufficiently rated to avoid limiting power flows on any feeders; and
- Existing structures and foundations are to be reused where possible, ensuring they are fit for purpose for a minimum of 40 years.

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

4.1.3. Telecoms Works

Not applicable

4.1.4. Easement/Land Acquisition & Permits Works

Not applicable

4.2. Key Scope Assumptions

Not applicable

4.3. Variations to Scope (post project approval)

Not applicable

5. Key Asset Risks

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

6. Project Timing

6.1. Stage 1 Approval Date

The anticipated date by which the project will be Stage 1 approved is TBC.

6.2. Site Access Date

This is an operational substation, therefore, site access is available.

6.3. Commissioning Date

The latest date for the commissioning of the new assets included in this scope and the decommissioning and removal of redundant assets, is 30th June 2032.

7. Special Considerations

Not applicable

8. Asset Management Requirements

Equipment shall be in accordance with Powerlink equipment strategies.

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

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

9. Asset Ownership

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

10. System Operation Issues

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

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

11. Options

Not applicable

12. Division of Responsibilities

Not applicable

13. Related Projects

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

Attachment 1: Primary Plant to be Replaced under CP.0XXXX

Functional Location	Technical Object Type	Notes
H004-C02-597--5972	CIRCUIT BREAKER	Decommission bay =C02-Q20
H004-C02-835--8352	CIRCUIT BREAKER	
H004-C03-545--5452	CIRCUIT BREAKER	
H004-D05-706--7062	CIRCUIT BREAKER	
H004-D05-706--7061	DISCONNECTOR	
H004-D05-706--7065	DISCONNECTOR	
H004-D05-706--7066	DISCONNECTOR	
H004-D06-482--4822	CIRCUIT BREAKER	
H004-D06-482--4822CTA	CT	
H004-D06-482--4822CTB	CT	
H004-D06-482--4822CTC	CT	
H004-D06-482--4821	DISCONNECTOR	
H004-D06-482--4823	DISCONNECTOR	
H004-D10-441--4412	CIRCUIT BREAKER	
H004-D10-441--4412CTA	CT	
H004-D10-441--4412CTB	CT	
H004-D10-441--4412CTC	CT	
H004-D13-411--4112	CIRCUIT BREAKER	
H004-D13-411--1BUSCTA	CT	
H004-D13-411--1BUSCTB	CT	
H004-D13-411--1BUSCTC	CT	
H004-D13-411--3BUSCTA	CT	
H004-D13-411--3BUSCTB	CT	
H004-D13-411--3BUSCTC	CT	
H004-D13-411--4117	DISCONNECTOR	
H004-D13-411--4118	DISCONNECTOR	
H004-D13-412--4127	DISCONNECTOR	Decommission the isolator and connect bus
H004-D13-412--4128	DISCONNECTOR	Decommission the isolator and connect bus
H004-D17-401--4012	CIRCUIT BREAKER	
H004-D17-401--4015	DISCONNECTOR	
H004-D17-401--4016	DISCONNECTOR	
H004-C01-541--1TRFCTA	CT	
H004-C01-541--1TRFCTC	CT	
H004-M02-2CAP-2CAPCTA	CT	
H004-M02-2CAP-2CAPCTB	CT	
H004-M02-2CAP-2CAPCTC	CT	
H004-D04-794--20VTA	CVT	
H004-D04-794--20VTB	CVT	
H004-D04-794--20VTC	CVT	
H004-D16-7838-18VTA	CVT	

H004-D16-7838-18VTB	CVT	
H004-D16-7838-18VTC	CVT	
H004-D21-757--16VTA	CVT	
H004-D21-757--16VTC	CVT	
H004-D22-7839-19VTA	CVT	
H004-D22-7839-19VTB	CVT	
H004-D22-7839-19VTC	CVT	
H004-D07-779--7795	DISCONNECTOR	
H004-D07-779--7796	DISCONNECTOR	
H004-D08-780--7805	DISCONNECTOR	
H004-D08-780--7806	DISCONNECTOR	
H004-D09-491--4915	DISCONNECTOR	Decommission bay = D09
H004-D09-491--4916	DISCONNECTOR	
H004-D16-7838-78385	DISCONNECTOR	
H004-D16-7838-78386	DISCONNECTOR	

CP.03208 Mudgeeraba Primary Plant Replacement Concept Estimate

Table of Contents

1. Executive Summary

This concept estimate has been developed based on the CP.03208 Mudgeeraba Primary Plant Replacement PSR.

H004 Mudgeeraba substation was built in 1972 and some of the equipment are original and will be in service for 54 years by 2026. Maintenance records show deterioration of the condition of some of this equipment. There is significant network risk associated with the equipment failing in service or during maintenance or periodic testing, possibly resulting in extended interruption to supply.

The objective of this project is to replace selected primary plant in H004 Mudgeeraba substation by June 2032.

This project will follow the two (2) stage approval process.

1.1 Project Estimate

No escalation costs have been considered in this estimate.

		Total ($)
Estimate Class	5	
Base Estimate – Un-Escalated (2025/2026)		27,188,666
TOTAL		**27,188,666**

1.2 Project Financial Year Cash Flows

No escalation costs have been considered in this estimate.

DTS Cash Flow Table	Un-Escalated Cost ($)
To June 2026	125,000
To June 2027	268,250
To June 2028	6,299,137
To June 2029	5,085,364
To June 2030	5,085,364
To June 2031	5,085,364
To June 2032	5,085,364
To June 2033	154,824
TOTAL	**27,188,666**

2. Project and Site-Specific Information

2.1 Project Dependencies & Interactions

This project is related to the following projects:

Project No.	Project Description	Planned Commissioning Date	Comment
Dependencies			
Interactions			
CP.02729	Mudgeeraba Secondary System Replacement	December 2029	Sec-sys replacement
Other Related Projects			
CP.02984	Trench CVT Replacement – South Phase 1	Dec 2027	Statewide CVT Replacement

2.2 Site Specific Issues

- H004 Mudgeeraba substation is located on Scottsdale Road, Varsity Lakes, Gold Coast, approximately 1.5 hours south from the Brisbane CBD.
- Asbestos Containing Material (ACM) has been identified within equipment and throughout the substation. Ensuring the ACM is maintained in a condition that prevents exposure may be compromised if major refurbishment works are undertaken on the identified equipment.
- There are 4 [redacted] at H004 Mudgeeraba which have invoked a Restricted Access Zone(s) (RAZ) in the substation. The RAZ does not impact access to the H004 Mudgeeraba Control Buildings, however access to the 275kV substation yard is restricted. An appropriate RAZ Works Plan will be required if the RAZ is not revoked by the time of works where access is required.
- The substation is located close to residential and commercial areas.
- Traffic control may be required for the safe access and egress from site for equipment deliveries.
- Main Access Gate is flood prone during inclement weather.
- Unfavourable ground conditions in wet weather.
- Proposed utilisation of bored piers for all foundations due to known ground conditions.
- H004 Mudgeeraba has operational HV and secondary systems cables that are buried direct.
- Water course at NW (front) corner of substation, adjacent to the main gate.
- Unknown soil contamination levels below ground level of the 110kV substation pad.
- The Hinze Dam area (nearest Bureau station) is subject to the following average number of days of rain. Consideration was given to this when developing the project schedule.

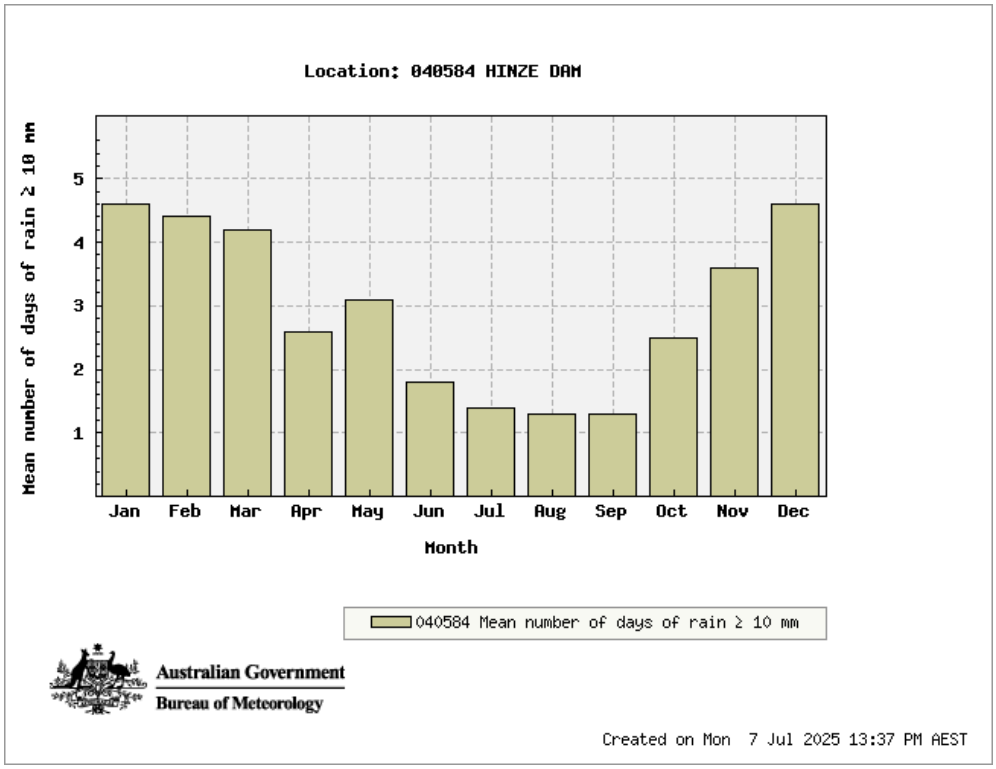


Figure 1 - Number of Days of Rain >10mm Hinze Dam (Source: Bureau of Meteorology 7th July 2025)

3. Project Scope

The following works have been costed for in the estimate.

3.1 Substations Works

H020 Mudgeeraba

- Design, procure, construct and commission replacement of the following primary plant utilising existing structures and foundations:
    - H004-C02-597--5972 [CIRCUIT BREAKER]
    - H004-C02-835--8352 [CIRCUIT BREAKER]
    - H004-C03-545--5452 [CIRCUIT BREAKER]
    - H004-D05-706--7062 [CIRCUIT BREAKER]
    - H004-D05-706--7061 [DISCONNECTOR]
    - H004-D05-706--7065 [DISCONNECTOR]
    - H004-D05-706--7066 [DISCONNECTOR]
    - H004-D06-482--4822 [CIRCUIT BREAKER]
    - H004-D06-482--4822CTA [CT]
    - H004-D06-482--4822CTB [CT]
    - H004-D06-482--4822CTC [CT]
    - H004-D06-482--4821 [DISCONNECTOR]
    - H004-D06-482--4823 [DISCONNECTOR]
    - H004-D10-441--4412 [CIRCUIT BREAKER]
    - H004-D10-441--4412CTA [CT]
    - H004-D10-441--4412CTB [CT]
    - H004-D10-441--4412CTC [CT]
    - H004-D13-411--4112 [CIRCUIT BREAKER]
    - H004-D13-411--1BUSCTA [CT]
    - H004-D13-411--1BUSCTB [CT]
    - H004-D13-411--1BUSCTC [CT]
    - H004-D13-411--3BUSCTA [CT]
    - H004-D13-411--3BUSCTB [CT]
    - H004-D13-411--3BUSCTC [CT]
    - H004-D13-411--4117 [DISCONNECTOR]
    - H004-D13-411--4118 [DISCONNECTOR]
    - H004-D13-412--4127 [DISCONNECTOR]
    - H004-D13-412--4128 [DISCONNECTOR]
    - H004-D17-401--4012 [CIRCUIT BREAKER]
    - H004-D17-401--4015 [DISCONNECTOR]
    - H004-D17-401--4016 [DISCONNECTOR]

- H004-C01-541--1TRFCTA [CT]
- H004-C01-541--1TRFCTC [CT]
- H004-M02-2CAP-2CAPCTA [CT]
- H004-M02-2CAP-2CAPCTB [CT]
- H004-M02-2CAP-2CAPCTC [CT]
- H004-D04-794--20VTA [CVT]
- H004-D04-794--20VTB [CVT]
- H004-D04-794--20VTC [CVT]
- H004-D16-7838-18VTA [CVT]
- H004-D16-7838-18VTB [CVT]
- H004-D16-7838-18VTC [CVT]
- H004-D21-757--16VTA [CVT]
- H004-D21-757--16VTC [CVT]
- H004-D22-7839-19VTA [CVT]
- H004-D22-7839-19VTB [CVT]
- H004-D22-7839-19VTC [CVT]
- H004-D07-779--7795 [DISCONNECTOR]
- H004-D07-779--7796 [DISCONNECTOR]
- H004-D08-780--7805 [DISCONNECTOR]
- H004-D08-780--7806 [DISCONNECTOR]
- H004-D09-491--4915 [DISCONNECTOR]
- H004-D09-491--4916 [DISCONNECTOR]
- H004-D16-7838-78385 [DISCONNECTOR]
- H004-D16-7838-78386 [DISCONNECTOR]

- For bays requiring both CB and CT replacement, a dead tank circuit breaker will be utilised.
- Decommission 275kV bay =C02-Q20, =D09 (remove disconnectors) and =D13-Q20 (between Bus 2 and Bus 4 by removing bridged disconnectors and join Bus 2 and Bus 4.
- Modify the secondary systems to facilitate the primary plant replacement.
- Brown post insulators supporting Busbar in Diameters =D13, =D14, =D16 and =D17 (including post insulators between bus isolator and CB in diameter =D17) and in between =D13 and =D14, =D15 and =D16 and =D17 and =D18 shall be replaced.
- Glass insulators on strung bus associated with diameters =D13, =D14, =D16 and =D17 shall be replaced.
- Decommission and recover all redundant equipment, including switchyard control cables.
- Update drawing records, SAP records and config files.

Primary plant to be replaced

Figure 2 - Mudgeeraba 275kV Line Diagram

Primary Plant to be replaced

Figure 3 - Mudgeeraba 110kV Line Diagram

Primary Plant to be replaced

Figure 4 - Mudgeeraba 110kV Line Diagram

3.2 Major Scope Assumptions

The following key assumptions were made for this Project Estimate.

- Powerlink internal Design teams and Design Services Panel will carry out the design work.
- Estimate is based on Powerlink architectures, standards and equipment in place and available at the time of development.
- H004 Mudgeeraba [redacted] will be replaced, revoking the Restricted Access Zones, prior to work starting on the site.
- No further Restricted Access Zones will be deployed on this site during project lifetime.
- Outages will be available on request. Please refer to Section 4.2 Network Impacts for further details.
- MSP resources will be available to complete the works.
- Procurement of long lead items align with project delivery requirements.
- Current transformers used for bus zone protection will be sufficiently rated to avoid limiting power flows on any feeders.
- Existing structures and foundations are to be reused where possible, ensuring they are fit for purpose for a minimum of 40 years.
- Bus outages will be available on request.

The following assumptions have been made with respect to Secondary Systems design:

- Bay marshalling kiosks to be re-used.
- AC Changeover board is fit for purpose and will be re-used.

The following assumptions have been made with respect to the Civil design:

- The existing substation platform and yard drainage system drains freely and is fit for purpose.
- The existing internal substation roads are fit for purpose.
- Drainage for any new pits shall be provided into the existing drainage system or off the substation platform.
- Existing structures and foundations are fit for purpose.

3.3 Scope Exclusions

The following items are excluded from the Proposal Estimate:

- Easement acquisitions work, including permits, approvals, development applications or the like. All works are within Powerlink-owned land.
- Additional time and cost for Design, Planning and Implementation of any restoration plans required for outages is not included in this estimate.
- No major modification to the earth grid is included in this estimate.
- Remove rock or unsuitable material, including asbestos and other contaminants.
- This estimate does not include any costs for repairing or modification to the primary plants not listed to be replaced under the scope.
- No modification and upgrade of the internal roads, lights, fences, gates and extension to platform.
- No consideration for the location and layout of the existing conduits & underground cables.
- No modification on the existing transmission lines is considered in this estimate.
- No allowance has been made for Live Substation work.

4. Project Execution

4.1 Project Schedule

This project will follow the two (2) stage approval process.

A High-Level Project Schedule has been developed for the project stages:

Milestones	High-Level Timing
Request for Class 5 Estimate	January 2026
Class 5 Project Proposal Submission	April 2026
Request for Class 3 Estimate	June 2026
Class 3 Project Proposal Submission	December 2026
Stage 1 Approval (PAN1) includes funds for design, procurement & ITT preparation.	March 2027
RIT-T (assumed 26 weeks)	March 2027 – September 2027
Project Development Phase 1 & Phase 2	March 2027 – September 2027
ITT Submission (8 Weeks)	August 2027 – September 2027
Evaluate Tender, Reconcile Estimate and Submit PMP for Stage 2 Approval	October 2027
Stage 2 Approval (PAN2)	November 2027
Execute Delivery (including award of SPA contract)	November 2027
SPA Site Establishment	February 2028
SPA Civil Works and Construction	March 2028 – April 2032
MSP Site Establishment	May 2028
Staged Bay Construction and Commissioning	June 2028 – June 2032
Project Commissioning	June 2032

4.2 Network Impacts

Powerlink Net Ops – Operating Manual 02 – SE QLD provides the following recommendations for outages of H004 Mudgeeraba feeders.

110kV H004 Mudgeeraba Feeders

An outage on Feeder 757 has the following network requirements and impacts.

- Network Requirements:
  - Feeder 758 in service.
- H004 Mudgeeraba ECS to be disabled.
- Time of Year Guidelines:
  - Do not proceed with outages if LOR has been issued in Qld or NSW without consultation with RTNO Outage Engineers.
  - May be subjected to summer guideline restrictions as defined by AEMO Guideline for Transmission Network Outage Planning.

An outage on Feeder 779 has the following network requirements and impacts.

- Network Requirements:
  - 110kV feeder 798 in service.
  - Remaining 110kV network between H031 Molendinar and H004 Mudgeeraba intact.
  - H004 Mudgeeraba 1T + 5T in service.
  - 275kV feeders 835 + 836 in service.
  - If Feeder 779 is OOSE, protection permits to be applied on remaining in service feeder.
- Customer Impact
  - Load at risk – Energy Qld (Energex).

An outage on Feeder 706 has the following network requirements and impacts.

- Network Requirements:
  - 110kV feeder 7229 in service.
  - Remaining 110kV network between H031 Molendinar and H004 Mudgeeraba intact.
  - H004 Mudgeeraba 1T + 5T in service.
  - 275kV feeders 835 + 836 in service.
- Customer Impact
  - Load at Risk – Energy Qld (Energex).

An outage on Feeder 794 has the following network requirements and impacts.

- Network Requirements:
  - 110kV feeders 7229 in service.
  - Remaining 110kV network between H031 Molendinar and H004 Mudgeeraba intact.
  - H004 Mudgeeraba 1T + 5T in service.
  - 275kV feeders 835 + 836 in service.
- Customer Impact

- Load at Risk – Energy Qld (Energex)

275kV H004 Mudgeeraba Feeders

An outage on Feeder 835 has the following network requirements and impacts.

- Network Requirements:
  - 275kV feeder 836 in service.
  - 275kV feeders 8824/ H031 Molendinar 1T + 8825/ H031 Molendinar 2T in service.
  - 275/110kV H004 Mudgeeraba 1T + 5T in service.
  - All Directlink feeders in service.
  - 110kV network from T108 Beenleigh to H031 Molendinar intact.
  - 110kV network from H031 Molendinar intact to H004 Mudgeeraba intact.
- Time of Year Guidelines
  - Avoid scheduling outages in summer due to risk of overloading beyond the 2-hour feeder limit.
  - If necessary, reduce recall duration and plan completion by 15:00 hrs, confirming feasibility with Outage Engineers, especially during high loads when outages may not proceed if recall exceeds 1 hour or occurs before 15:00 hrs.
  - Outage may be subjected to summer guideline restrictions as defined by AEMO Guideline for

An outage on 1T has the following network requirements and impacts.

- Network Requirements
  - Remaining H004 Mudgeeraba 275/110kV transformer 5T in service.
  - 275kV feeders 8824 + 8825 in service.
  - 275/110kV H031 Molendinar 1T + 2T in service.
  - 110kV feeder F916 in service.
  - All Directlink feeders in service.
  - 110kV network from T108 Beenleigh to H031 Molendinar intact.
  - 110kV network from H031 Molendinar intact to H004 Mudgeeraba intact.
- Time of Year Guidelines
  - Avoid scheduling outages in summer due to high load impact risk.
  - if unavoidable, ensure restoration by 16:00 hrs and confirm feasibility with Outage Engineers, especially if recall times exceed 1 hour or occur before 15:00 hrs.
  - Transmission Network Outage Planning.

4.3 Resourcing

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

5. Project Asset Write-Off

Asset Class	Base ($)	Base (%)
Substation Primary Plant	24,744,872	91%
Substation Secondary Systems	2,211,780	8%
Telecommunications	-	-
Overhead Transmission Line	232,014	1%
TOTAL	**27,188,666**	**100%**

6. References

Document name and hyperlink	Version	Date
Project Scope Report	1.0	6/06/2025

Risk Cost Summary Report

CP.03208

Mudgeeraba Selective Primary Plant Replacement

Document Control

Change Record

Issue Date	Revision	Prepared by
22/12/2025	1.0	Asset Strategies

Related Documents

Issue Date	Responsible Person	Objective Document Name

Document Purpose

The purpose of this model is to quantify the base case and option risk cost profiles for the equipment at the Mudgeeraba Substation which are proposed for reinvestment under CP.03208. These risk cost profiles are then included as part of an overall cost-benefit analysis (CBA) to understand the economic benefit of the proposed upgrades. This process provides a benchmarking and internal gate process to support Powerlink in effectively identifying prioritised infrastructure upgrades.

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

Key Assumptions

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

- The functionality of the equipment is assumed to decay according to decay curves calculated by Powerlink, and associated probability of failure (PoF).
- Where equipment in scope is replaced, its associated Health Index (HI) score is reverted to one.
- The likelihood of personnel within the substation in the event of explosive failure of equipment (used to calculate safety risk) is assumed to be 25% (based upon historic site entry averages), with the likelihood of resulting injury or death depending on the explosive radius of the equipment, its housing, and the total substation land area. The modelling also assumes that personnel are equally likely to be anywhere within the substation land area. No escalation to the likelihood has been made during construction as it is assumed appropriate risk assessments and risk mitigation measures are completed by the project team.
- In the event of an SF6 gas leak, it is assumed that the entire quantum of SF6 gas is leaked.
- For the purposes of the cost-benefit analysis, the total useful asset life of 40 years has been applied.
- A site-specific value of customer reliability (VCR) of $25,060 has been applied when calculating network risks.

Base Case Risk Analysis

Risk Categories

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

- Financial Risk
- Safety Risk

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

Table 1: Risk categories

Risk Category	Failure Types	Equipment in scope
Safety Risk	Explosive failure	All equipment with the potential to fail explosively
Financial Risk	Peaceful failure	All equipment
	Explosive failure	All equipment with the potential to fail explosively
Network Risk	Peaceful failure	All equipment related to network elements identified in the planning statement
Environmental Risk	Peaceful failure	Circuit breakers and current transformers containing SF6

Base Case Risk Cost

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

Risk costs associated with the equipment in scope are expected to increase from $1.41 million in 2026 to $3.22 million in 2036 and $6.03 million by 2046. Key highlights of the analysis include:

- Financial risk forms approximately 61% of the base case risk. Of this, the majority is a result of peaceful failures modes with the risk dollars spread evenly across the bays included for re-investment.
- Network risk and safety risk accounts for approximately 36% and 3% of the total risk. A lower proportion of network risk is reflective of the circuit breaker and a half substation arrangement while low safety risks reflect a conservative assumption that personnel are unlikely to be in proximity of equipment during an explosive failure event
- Whilst environmental risk has been calculated it is immaterial to the overall base case risk.

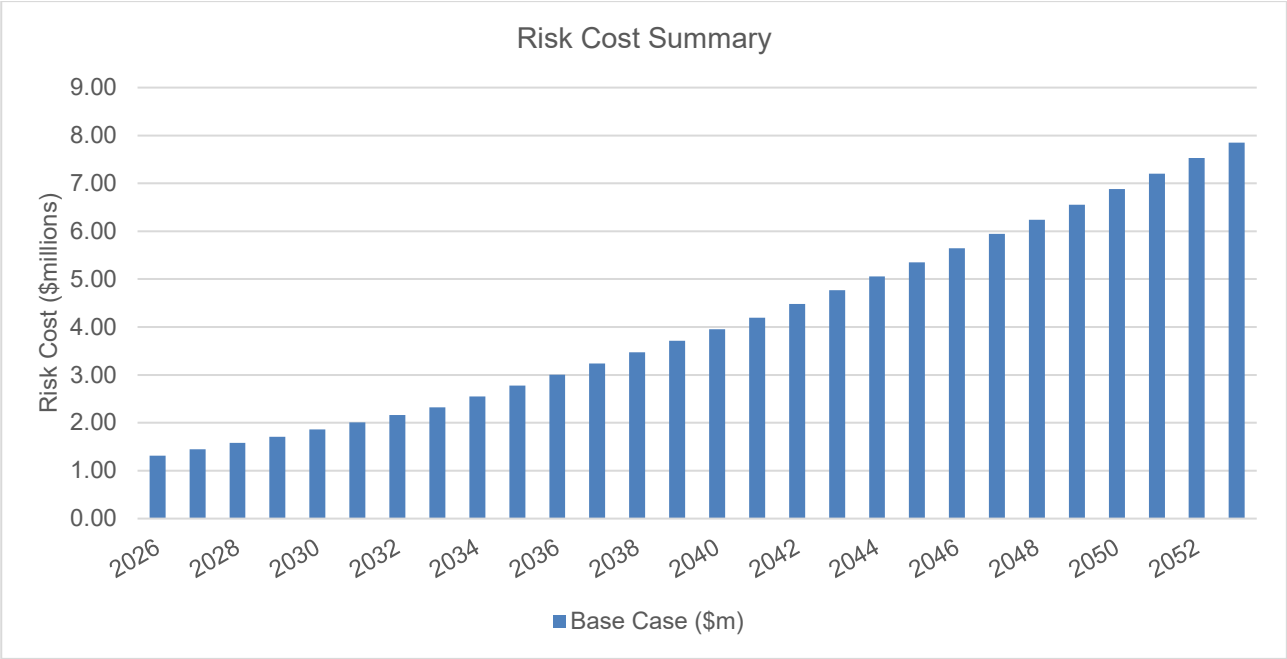


Figure 1: Total risk cost

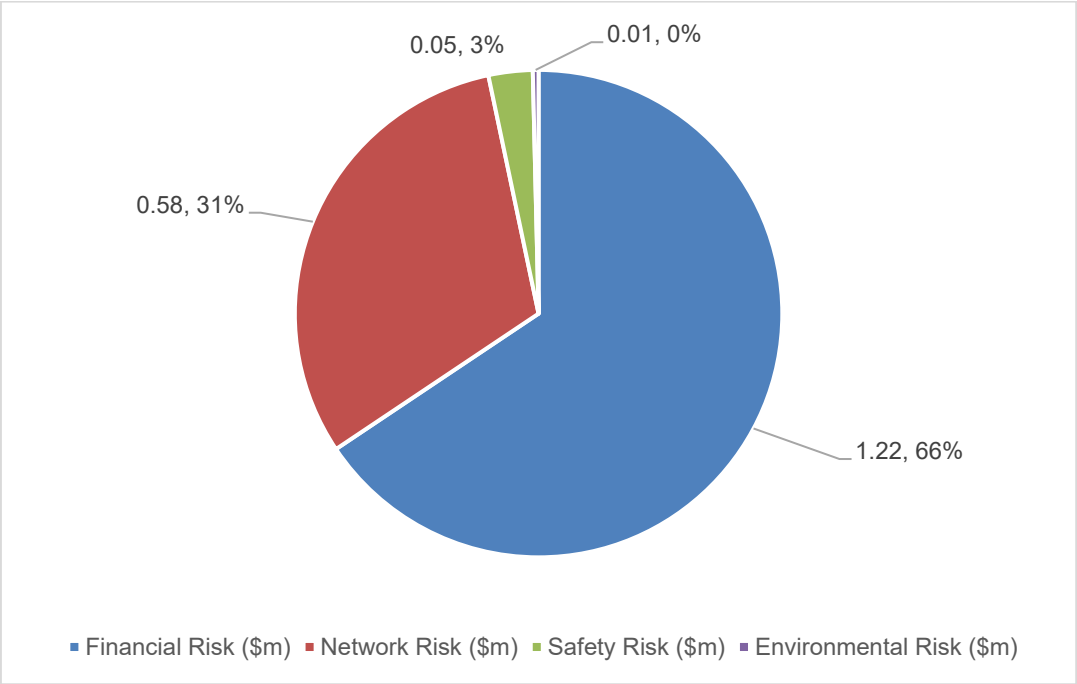


Figure 2: Base case risk cost by contributions (2030)

Option Risk Cost

For modelling purposes, the replacement of equipment at the Mudgeeraba substation reduces effective HI scores to one, significantly lowering its probability of failure and therefore risk cost.

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

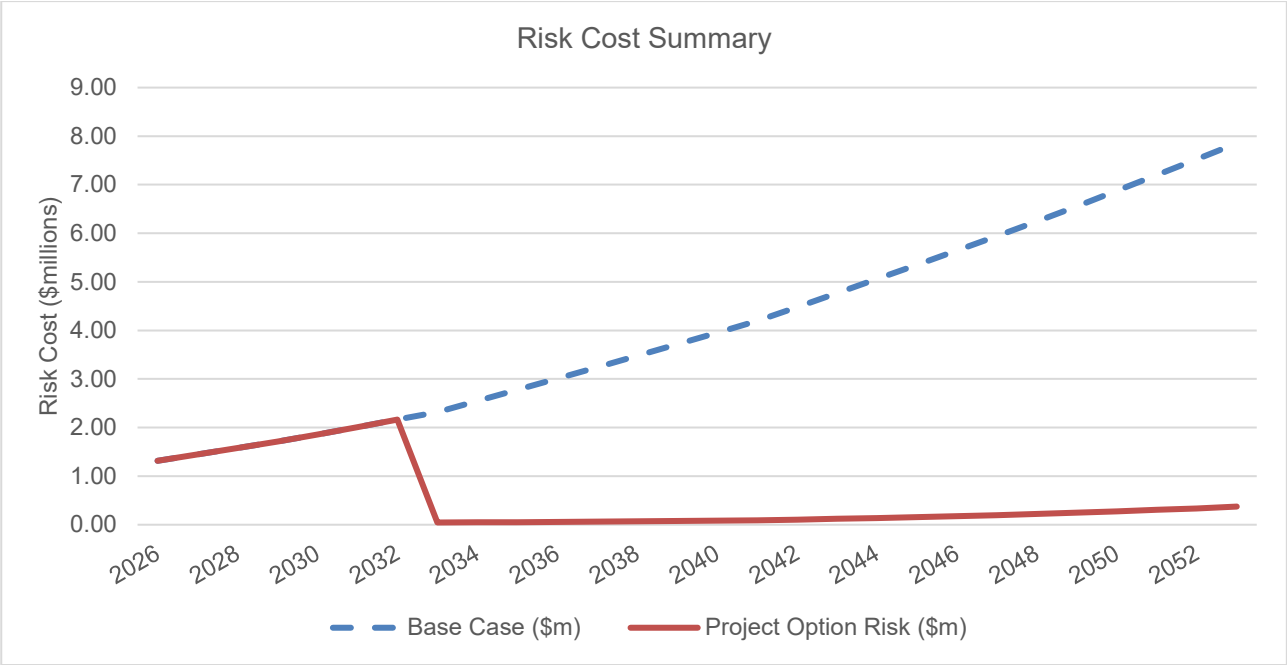


Figure 3: Project Option Risk Cost (compared to base case)

Following the year of investment (2031) the risk cost associated with the equipment in scope effectively reduces to approximately $0.05m. By 2046, the risk cost of the project option is approximately $0.18 million, compared with the base case risk cost of $6.03 million.

Cost Benefit Analysis

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

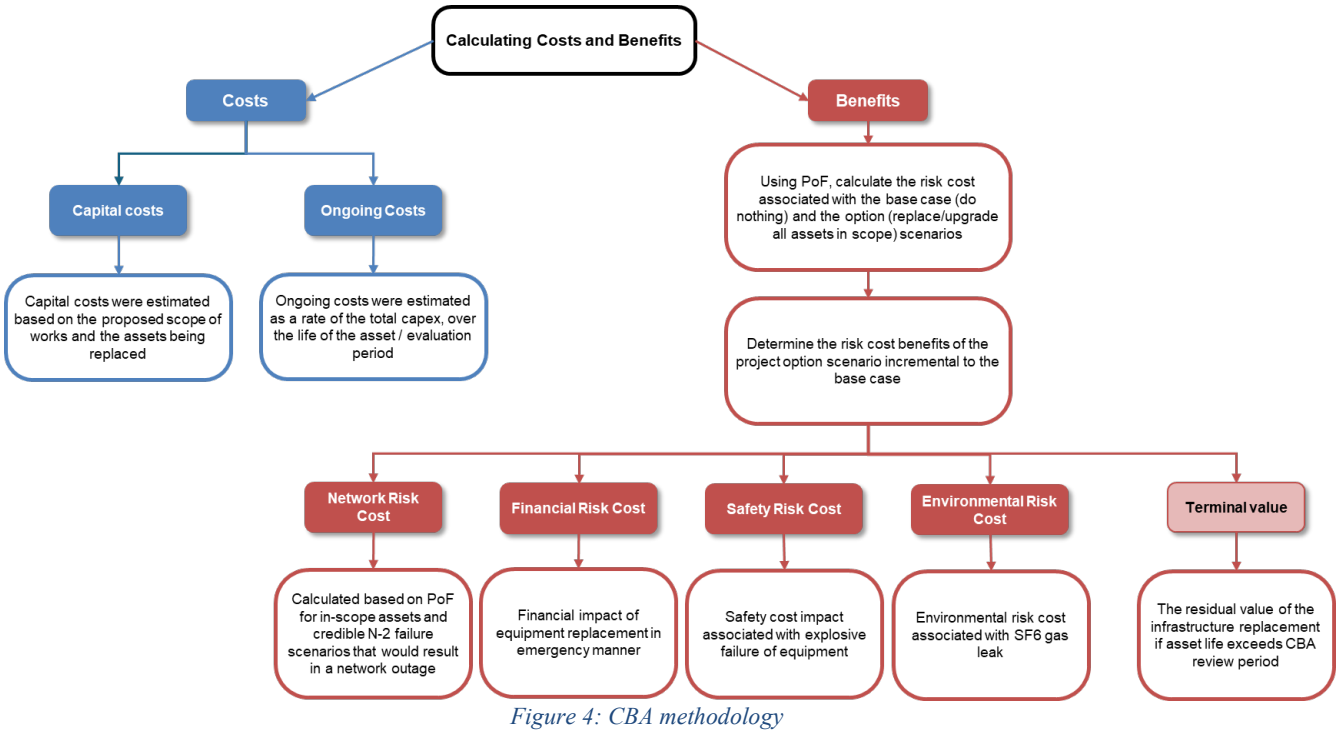


Figure 4: CBA methodology

The project is estimated to cost approximately $27.19 million. This represents a significant cost saving over the estimated financial risk cost of replacing assets individually in an emergency manner, due to the efficiencies associated with planned upgrades.

Based on a baseline discount factor of 7%, the project has a net present value (NPV) of $21.0 million over a 35-year period, and a benefit-cost ratio (BCR) of 2.24.

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

Given this, replacement of the nominated assets within this project is considered appropriate.

Table 2: Net Present Value and Benefit-Cost Ratio

		Present Value Table ($m)		
Discount rate	**%**	**3%**	**7%**	**10%**
NPV of Net Gain/Loss	$m	$65.8	$21.0	$7.9
Benefit-Cost Ratio	ratio	3.98	2.24	1.57

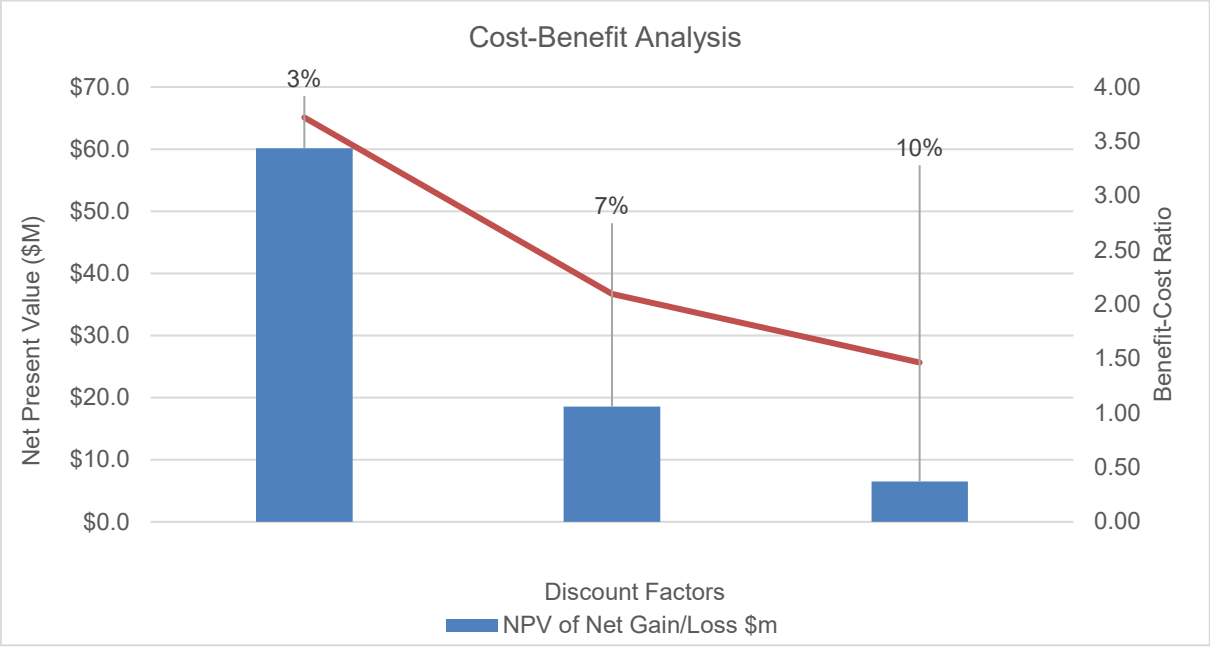


Figure 5: Cost benefit summary

Participation Factors

A sensitivity analysis was undertaken to determine the participation factors for key inputs to the risk cost models (i.e. to identify which inputs are most sensitive to overall risk cost). Applying a 50% reduction in key inputs still resulted in a cost benefit ratio greater than 1.85.

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

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

The model is most sensitive to:

- **changes in value of customer reliability** results in a decrease in risk cost of $0.35 million, or approximately 17.78% of the original base risk.
- **changes in the restoration time** in the event of a network outage (halving the return to service time) represents decrease in risk cost of $0.35 million, or approximately 6.56% of the original base case risk.

Table 3: Participation Factors

Input	Baseline value	Sensitivity value (-50%)	Change in risk cost at 2030 ($m)	Participation (%)
Safety				
Likelihood of personnel within substation	25%	12.5%	-0.03	-1.37%
Cost consequence of multiple fatality	$11,400,000	$5,700,000	-0.01	-0.42%
Cost consequence of single fatality	$5,700,000	$2,850,000	-0.02	-0.94%
Cost consequence of multiple serious injury	$4,206,600	$2,103,300	-0.01	-0.30%
Financial				
Emergency premium (peaceful failure)	20%	10%	-0.09	-4.63%
Emergency premium (explosive failure)	300%	150%	-0.04	-2.15%
Network				
VCR ($/MWh)	25,060	12,530	-0.35	-17.78%
Restoration Time (hrs)	72-720	36-360	-0.13	-6.56%