

January 2026

Powerlink 2027-32 Revenue Proposal

Project Pack

CP.02948 Chalumbin 275kV Substation Reinvestment



Forecast Capital Expenditure - Capital Project Summary

Powerlink 2027-32 Revenue Proposal

January 2026

Project Status: Unapproved

Network Requirement

The Chalumbin 275/132kV Substation was established in 1988 as part of the extension of the 275kV network north of Townsville to reinforce supply to Cairns and the Atherton Tablelands. The substation has undergone feeder and bay extensions and modifications since its original construction, that has resulted in a range of primary plant and secondary systems equipment with the majority dating from 1998 to 2014.

The primary plant from the original substation construction is now approaching 40 years old and requires selective replacement. 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 original underground cable and associated sealing ends for substation AC supply from the tertiary winding of Transformer 1 also requires replacement [1].

Ageing secondary systems, which are no longer supported by the manufacturer are increasingly at risk of failing to comply with Schedule 5.1.9(c) of the National Electricity Rules, AEMO's Power System Security Guidelines and the reliability standard included in Powerlink's Transmission Authority. A condition assessment of the Chalumbin Substation secondary systems identifies various secondary systems components requiring replacement due to their obsolescence and lack of support [2].

Powerlink's 2025 Central scenario load forecasts confirm an enduring need for an ongoing supply of bulk electricity to the Cairns and Atherton Tablelands area. In order to achieve this there is an enduring need to maintain the 275kV connection between Ross and FNQ (via Chalumbin Substation) and provide a 132kV connection to the Turkinje Substation and Kareeya Hydro Power Station.

The removal or reconfiguration of the Chalumbin 275kV Substation would violate Powerlink's N-1-50MW/600MWh Transmission Authority reliability standard. In addition, an outage of a critical transmission line due to equipment failure at Chalumbin Substation will significantly impact generation from one or more of the Mt Emerald and Kaban wind farms, the Lakeland solar farm and Kareeya Hydro Power Station and result in altered dispatch outcome in the National Electricity Market (NEM) and higher total system costs. Powerlink has undertaken market modelling to quantify the changes in costs for market participants due to those different dispatch outcomes [3].

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 selected primary plant and to undertake bus uprating works to meet future demand requirements.

The current recommended option involves the replacement of selected 275kV primary plant and the Built Section 1356 cables and replacement of selected 275kV secondary systems within the existing building, all by November 2030 [4].

Options considered but not proposed include:

- Do Nothing – rejected due to non-compliance with reliability obligations;
- Selected primary plant and cable replacement with deferred selected secondary system replacement – expected to be greater overall cost; and
- Non-network option – no viable non-network options have been identified at this time.

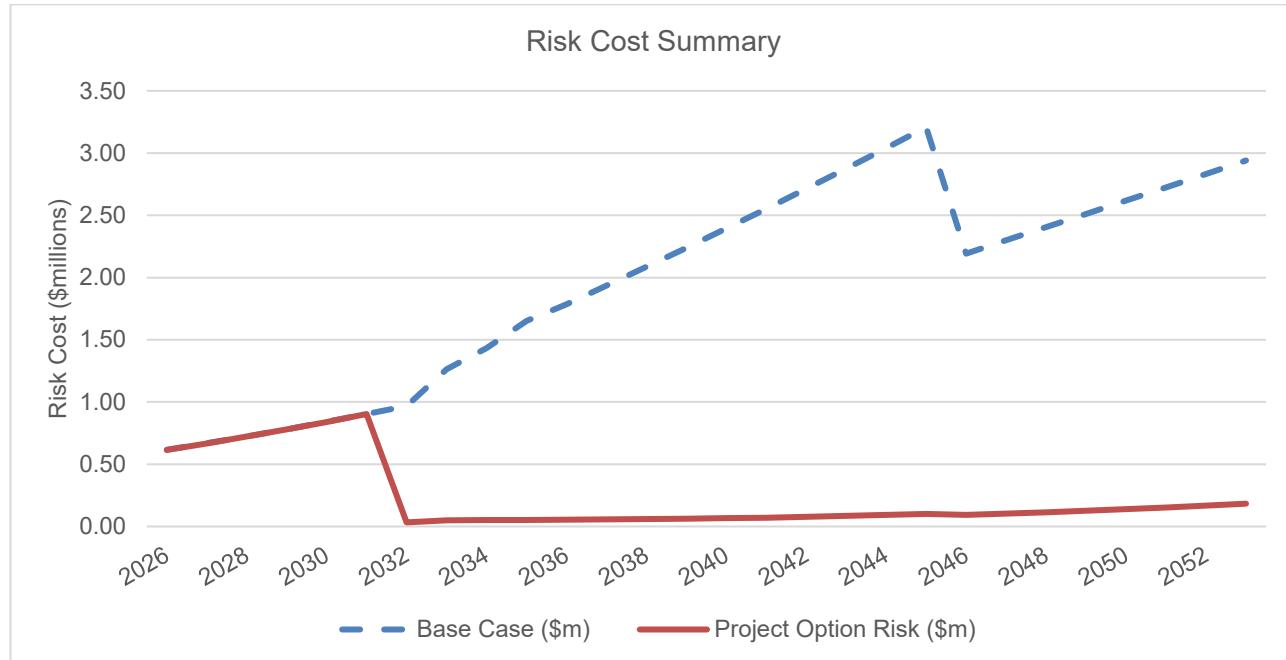
Forecast Capital Expenditure - Capital Project Summary

Powerlink 2027-32 Revenue Proposal

January 2026

Figure 1 shows the current recommended option reduces the forecast risk monetisation profile of the Chalumbin Substation primary plant from around \$0.9 million per annum in 2031 to less than \$0.05 million from 2032 [6]. In addition to this benefit of reduction in risk cost there are benefits available from lower cost market dispatch outcomes due to improved reliability and availability of Chalumbin 275kV Substation primary plant and secondary systems.

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



Cost and Timing

The estimated cost to replace selected 275kV primary plant, underground cable and selected 275kV secondary systems is \$29.9 million (\$2025/26) [5].

Target Commissioning Date: November 2030.

Documents in CP.02948 Project Pack

Public Documents

1. H032 Chalumbin Substation Condition Assessment Report
2. H032 Chalumbin Substation Secondary Systems Condition Assessment Report
3. CP.02948 Chalumbin 275kV Substation Reinvestment – Planning Statement
4. CP.02948 Chalumbin 275kV Substation Reinvestment – Project Scope Report
5. CP.02948 Chalumbin 275kV Substation Reinvestment – Concept Estimate
6. CP.02948 Chalumbin 275kV Substation Reinvestment – Risk Cost Summary Report



SITE CONDITION ASSESSMENT REPORT

H032 Chalumbin

Asset Category:	Substation primary	Author:	[REDACTED]	Authorisation:	[REDACTED]
Reviewed by:	[REDACTED]	Review Date:	17/02/2020		
Activity:	Condition assessment -275/132 KV primary substation plant and site infrastructure, incl. civil components – SITE BASED				
Document Type:	Report	Team:	Substation team		
Authorisation date:	[REDACTED]	Date of site visit:	24&25/9/2019		

Date	Version	Objective ID	Nature of Change	Author	Authorisation
15/12/2019	V1	A3187087	Original Report	[REDACTED]	[REDACTED]
1/05/2025	V2	A5638035	Updated with desktop information for primary plant replacement project	[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 or issue date (whichever is later) stated above.

Powerlink Queensland owns copyright and the confidential information contained in this document. No part of the document may be reproduced or disclosed to any person or organisation without Powerlink Queensland's prior written consent.

CONTENTS

+

EXECUTIVE SUMMARY	4
1. INTRODUCTION.....	4
1.1 SYSTEM INFORMATION.....	4
1.2 RATINGS	7
1.3 ASSET AGE	9
1.4 SCOPE OF SITE CONDITION ASSESSMENT.....	10
2. CONDITION ASSESSMENT	10
2.1 BUILDINGS.....	10
2.1.1 <i>Building layout and usage</i>	10
2.2 PRIMARY PLANT BAYS.....	11
2.2.1 <i>H032-C03-503 - 275kV 3 Coupler Bay</i>	11
2.2.2 <i>H032-C03-541 - 275kV 1 TRANSF BAY</i>	13
2.2.3 <i>H032-C03-857 – 857 Feeder</i>	14
2.2.4 <i>H032-C04-504 - 275kV 4 Coupler Bay</i>	16
2.2.5 <i>H032-C04-858 – 858 Feeder</i>	16
2.2.6 <i>H032-C06-8932 – 8932 Feeder</i>	18
2.2.7 <i>H032-D03-411 - 132kV 1-2 BUS SECTION BAY</i>	19
2.2.8 <i>H032-D04-441- 132kV 1 Transformer Bay</i>	20
2.2.9 <i>H032-D05-7191 – 7191 Feeder Bay</i>	22
2.2.10 <i>H032-D06-442 - 132kV 2 TRANSF BAY</i>	23
2.2.11 <i>H032-D06-7192 - 7192 Feeder Bay</i>	24
2.2.12 <i>H032-D07-7166 - 132kV Feeder Bay</i>	25
2.2.13 <i>H032-D08-7165 7165 Feeder Bay</i>	26
2.2.14 <i>H032-F01- 271- 19kV 1 Reactor Bay</i>	27
2.3 BUS DIAMETERS	28
2.3.1 <i>132kV Bus</i>	28
2.3.1 <i>275 kV Bus</i>	28
2.4 STRUNG BUS AND STRUCTURES	29
2.5 SITE INFRASTRUCTURE.....	29
2.5.1 <i>AC supply</i>	29
2.5.2 <i>Security Fence</i>	30
2.5.3 <i>Substation Access and Internal Roads and Signage</i>	31
2.5.4 <i>Substation Yard, Platform and Site Drainage System</i>	31
2.5.5 <i>Cable Trenches</i>	31
2.5.6 <i>Yard Lights</i>	32
2.5.7 <i>Substation earthing</i>	32
3. OVERVIEW OF RECOMENDATIONS.....	32
3.1 CONCLUSIONS	33
4. APPENDICES	34
4.1 REPLACEMENT INDEX METHODOLOGY	35

EXECUTIVE SUMMARY

This report provides an overview assessment of the condition of the Powerlink owned high voltage equipment and site infrastructure only at H032 Chalumbin substation.

The report is intended to assist with determining the future strategies for refurbishment or replacement of high voltage equipment and site infrastructure in Chalumbin substation.

The assessment has been formulated based on the data extracted from computerised maintenance management system (SAP) including notifications and work orders, dissolved gas analysis (DGA) and other test and measurement results, equipment age information combined with available photos, historical data analysis, site inspection and civil condition assessment report dated 29/10/2019 (Objective Id. A3237809).

The summary of recommendations is contained in Section 3 of this report and is updated based on the review of maintenance and project data updated to September 2024.

1. INTRODUCTION

This condition assessment is based on a site visit conducted on 25/9/2019, information provided in civil engineering condition assessment report dated 29th October 2019, available design data and drawings, SAP data and information provided by the maintenance service providers. This report was further updated in September 2024 with information available from a desktop review.

1.1 System information

Chalumbin Substation is located in Far North Queensland (FNQ) and has 275/132kV operating voltages in one yard.

Chalumbin Substation is connected via four 275kV feeders to Woree and Ross substations and is the major substation in 275kV in land power transfer corridor between Central Queensland and FNQ.

There are two 275/132kV transformers located in Chalumbin enabling power transfer into local 132 kV network in Cairns region through two 132kV feeders (F7165 and F7166) connected to the Turkinje substation and connection of 88MW of power generated at Stanwell Kareeya hydro power station through two 132 kV feeders (F7191 and F7192).

Chalumbin Substation was established in 1988. The majority of Primary equipment is the original installation and is now around 30 years old.

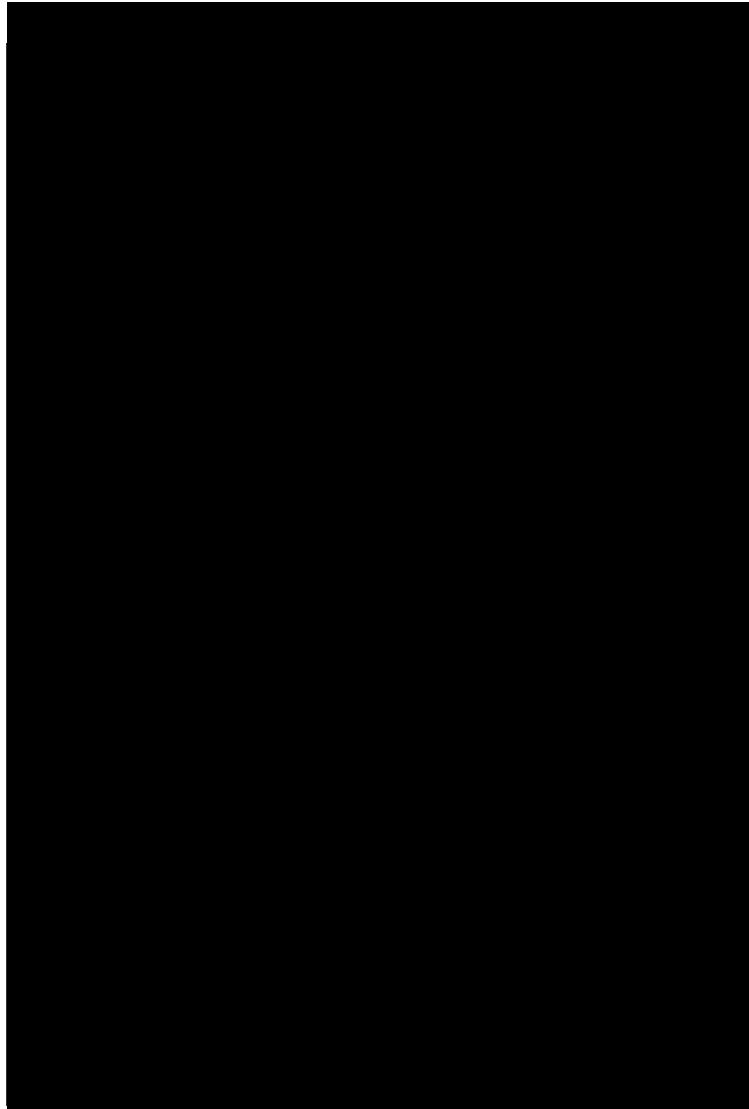


Figure 1 - Single Line Diagram

H032 Chalumbin substation consists of:

- two 275 kV busbars,
- two 275kV transformer bays,
- four 275 kV feeder bays,
- three 275 kV bus coupler bay and
- one 275kV reactor bay.

It also has:

- two 132 kV busbars,
- two132kV transformer bays,
- four 132kV feeder bays,
- one 132kV bus coupler bay,
- one 132kV capacitor bank bay and

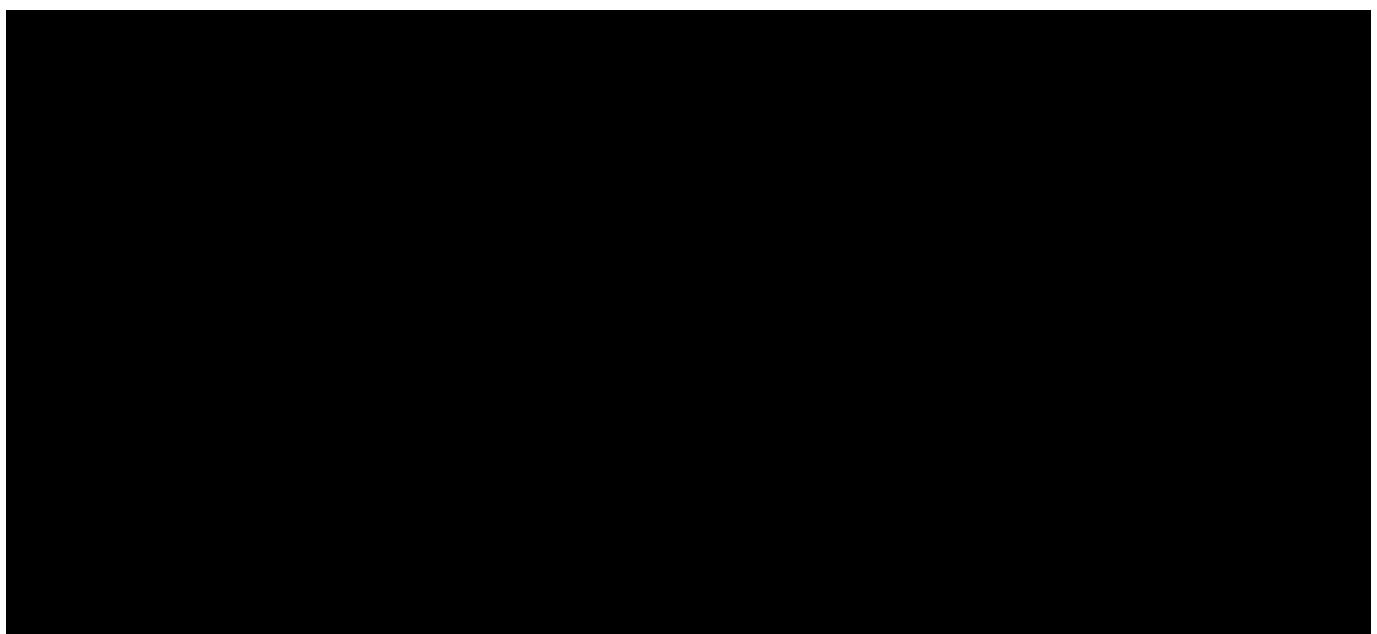
- three 19 kV bays (two for substation supply transformers connection and one 19kV reactor bay).

In addition, there are:

- two power transformers 275/132 kV (2 X 150/200 MVA),
- one 132 kV capacitor bank (48.3 MVar),
- one 19kV air core reactor,
- two 35MVA oil filled line reactors,
- one 35MVA oil filled bus reactor and
- two local supply transformers 19.1 /0.433 kV (1X315 kVA and 1X 200 kVA).



Figure 2 – Aerial view



DRAWING REFERENCES
Figure 3 – General Arrangement

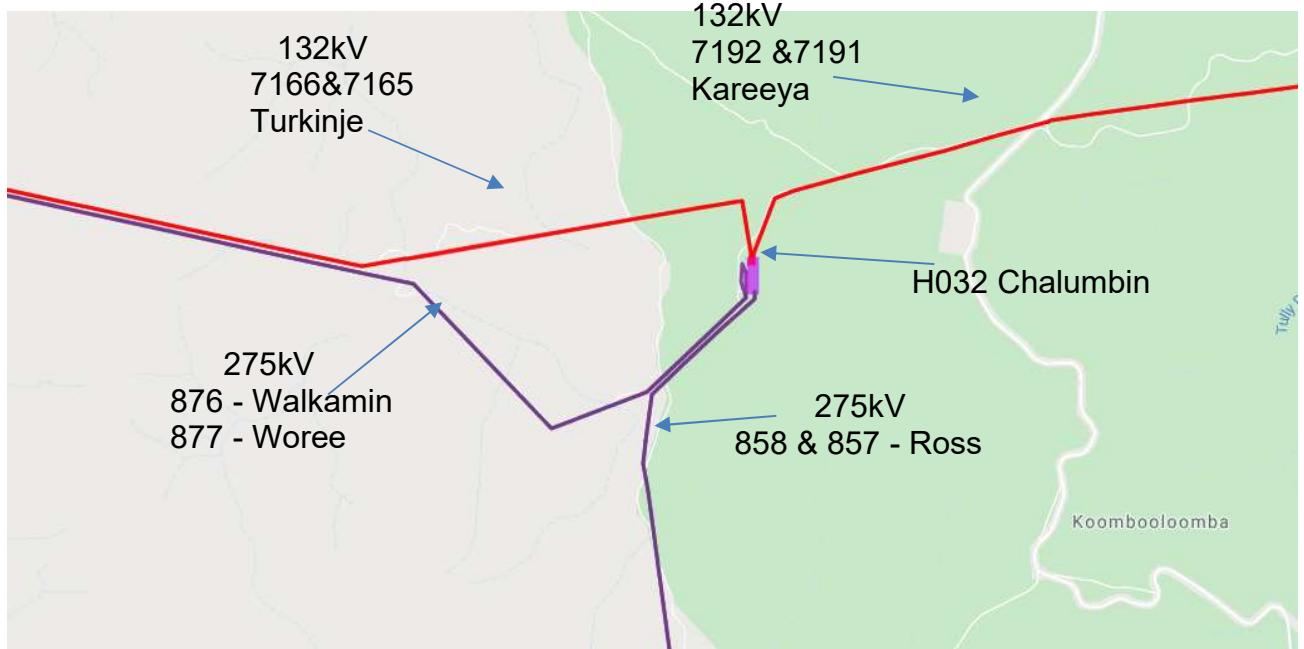


Figure 4 - Overview of HV Supply Network

1.2 Ratings

The maximum fault levels calculated in 2024 are:

- 19.1kV 3 phase – 9.99 kA
- 132kV L-G – 8.54 kA
- 275kV L-G – 5.60 kA

Below table provides overview of continuous current and fault current ratings of all high voltage bays in Chalumbin substation, incl. recommendations.

Functional Loc.	Bay Description	Start-up date	Bay Cont. Rating (A)	Bay Fault Current Rating (kA)	Fault Current Period (s)	Comments on rating
H032-D03-411	132KV 1-2 Bus Section	01/07/1996	1600	31.5	1.0	Limited by the CT's and Disconnectors.
H032-D04-441	132kV 1 TRNSF	01/07/1988	1157	31.5	1.0	Bay limits 2H short term transf. rating
H032-D05-7191	7191 FEEDER	01/07/1996	1275	31.5	1.0	Sufficient rating
H032-D06-442	132kV 2 TRANSF	01/07/1997	1275	31.5	1.0	Bay limits 2H short term transf. rating
H032-D06-7192	7192 FEEDER	01/07/1988	1200	31.5	1.0	Sufficient rating
H032-D07-7166	7166 FEEDER	01/07/1988	1200	31.5	1.0	Sufficient rating
H032-D08-7165	7165 FEEDER	01/07/1996	1200	31.5	1.0	Sufficient rating
H032-D09-481	132kV 1 Capacitor	01/09/2001	1000	40	1.0	Sufficient rating
H032-C03-503	3 Coupler 275kV	01/07/1989	2500	31.5	1.0	Sufficient rating
H032-C03-541	275kV 1 TRANSF	01/07/1988	1250	31.5	1.0	Sufficient rating
H032-C03-857	857 Feeder	01/07/1988	1600	31.5	1.0	Sufficient rating
H032-C04-504	4 Coupler 275kV	01/07/1993	2500	31.5	1.0	Sufficient rating
H032-C04-542	275kV 2 TRANSF	01/07/1997	1250	31.5	1.0	Sufficient rating
H032-C04-858	858 Feeder	01/07/1993	1600	31.5	1.0	Sufficient rating
H032-C05-575	1 Bus 5 Reactor	10/04/2014	2500	40	1.0	Sufficient rating
H032-C06-506	6 Coupler 275kV	04/10/2004	2500	40	1.0	Sufficient rating
H032-C06-876	876 Feeder	31/07/2007	2500	40	1.0	CT ratio limits summer emergency rating
H032-C06-877	877 Feeder	04/10/2004	2500	40	1.0	Sufficient for UGC
H032-F01	1 Stn Transformer	15/12/2018	2	31.5	1.0	Sufficient rating
H032-F02	2 Stn Transformer	30.09.2001	25A	31.5	1.0	Sufficient rating
H032-KC1	275kV 1 Bus	01/07/1996	3500	31.5	1.0	Sufficient rating
H032-KC2	275kV 2 Bus	01/07/1996	3500	31.5	1.0	Sufficient rating
H032-KD1	132kV 1 Bus	01/07/1996	1600	31.5	1.0	Potential upgrade to 4000A
H032-KD2	132kV 2 Bus	01/07/1996	1600	31.5	1.0	Potential upgrade to 4000A

Table 1: H032 Chalumbin Bay Ratings

All equipment at this site are rated adequately for the calculated fault levels at present and for the next 10 years.

Recommendation:

1. 1-2 Bus Section bay is below the standard rating of 3150A, however it appears sufficient for the maximum expected load for the coupler during a contingency. It is recommended the Planning Team should review the future expected load for the coupler for a range of credible contingencies and the bay should be uprated if required.
2. 132kV T1 and T2 bay limits the 2 hour short term and 10 minute rating of the transformer. The data show that limiting element is the transformer flexible connection for T1 and the interplant connections for T2. The present rating appears sufficient for the transformer to handle the maximum load whilst the other transformer is OOS. It is recommended the Planning Team should review the future expected load for the transformers to identify any need to increase the rating.
3. 876 Feeder bay is limited by the CT ratio to 1600A, this is below the feeder rating of 2284A (winter 2m/s). Loading appears to be significantly less than 1600A and is therefore unlikely to exceed the bay limits. It is recommended the Planning Team to review the future expected load for the feeder to identify any need to increase the rating.
4. 132 kV 1 Bus and 2 Bus are limited to 1600A, this is below our standard rating of 4000A, however this appears sufficient for the maximum expected load on the bus during a contingency. It is recommended for the Planning Team to review the future expected load for the Bus 1 and Bus 2 for a range of credible contingencies and uprated if required.

Note: the loading assumptions are based on historical loading from the past 12 months and may not represent future loads especially if new generation is added to the area.

1.3 Asset age

The Chalumbin 275/132kV substation was established in 1988, with some equipment replacements/upgrades detailed below.

Major upgrades in the last 20 years include:

- CP.00576 Chalumbin 132kV Cap bank No.1
- CP.00577 Chalumbin 132kV Cap Bank No. 2
- CP.01047 Chalumbin 18kV Reactor Replacement
- CP.02000 132kV 50MVAr Capacitor Bank
- CP.02095 Chalumbin No.1 Bus Reactor
- CP.02476 Chalumbin No.2 Bus Reactor
- CP.00526 Chalumbin Transformer Augmentation.
- CP.01566 Chalumbin secondary systems modification
- CP.02786 Chalumbin secondary systems modification
- CP.01042 Ross-Chalumbin 275kV line switching

1.4 Scope of site condition assessment

The site condition assessment is restricted to Powerlink owned and operated high voltage equipment and site infrastructure in H032 Chalumbin substation with the **exclusion** of:

- Power transformers T1&T2, and all reactors (subject of separate condition assessment report)
- H032-C04-542- 275kV 2 Transformer bay (established in 1997)
- H032-C05-575- 1 BUS 5 Reactor bay (established in 2014)
- H032-C06-506 - 275kV 6 Coupler Bay (established in 2004)
- H032-C06-876- 876 Feeder Bay (established in 2007)
- H032-D06-442 - 132kV 2 Transformer Bay (established in 1997)
- H032-D09- 481- 1 Capacitor Bank Bay (established in 2001)
- Protection and control systems which are subject to a separate condition assessment report

2. CONDITION ASSESSMENT

2.1 Buildings

2.1.1 *Building layout and usage*

This site has two control buildings; a demountable 132kV control building and a brick built 275 kV control building. The Powerlink owned 275 kV control building is used to house Powerlink 275kV control panels, the 125V and 50V DC supply systems and telecommunication equipment. It consists of control/relay room, telecommunications room, battery room, amenities room and toilet. The control, battery and telecomms rooms are all air conditioned. The building is equipped with intruder alarm system, has sufficient lighting, access to protection and control panels and is maintained in good condition. There are some vacant spaces in this building and at high level it is assessed that only minor substation extensions to protection system can be done within the space available.

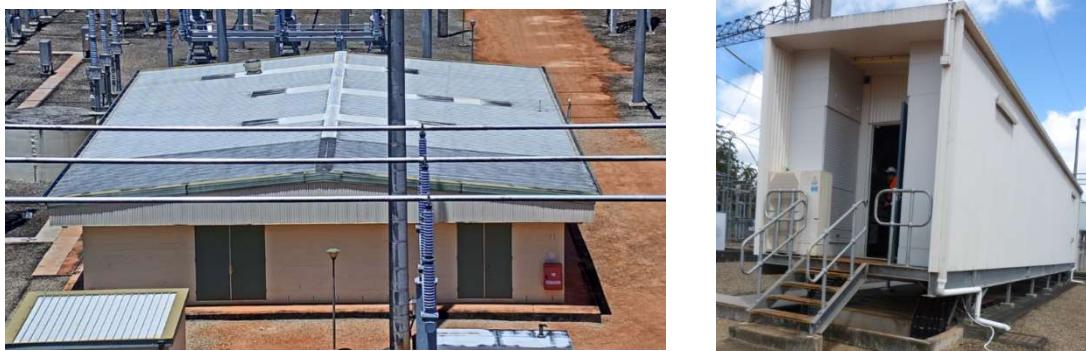


Figure 5 – Substation buildings

The substation asbestos register indicates that no asbestos was detected in the brick built building.

The demountable building is relatively new as it was installed in 2012 under the secondary system project upgrade. The building is in as new condition and no issues were detected.

Recommendation: Based on the condition it is recommended that the brick and demountable building have estimated remaining service lives of 40 years with maintenance.

2.2 Primary Plant Bays

The insulator sheds of all the primary in this bay has mould which requires cleaning, this mould is due to the tropical weather condition in FNQ region.

2.2.1 H032-C03-503 - 275kV 3 Coupler Bay

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

The original equipment comprising circuit breaker, disconnectors and current transformers was installed in early to mid-1989.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-C03-503--5030-1	EARTH SWITCH	MORLYNN	VSB	28.02.1989	6
H032-C03-503--5030-2	EARTH SWITCH	MERLIN GERIN		10.09.1993	5
H032-C03-503--5032	CIRCUIT BREAKER	ASEA	HPL300/25B1	28.02.1989	8
H032-C03-503—5032CTA	CT	HAEFELY	IOSK300/1050	28.02.1989	7
H032-C03-503—5032CTB	CT	HAEFELY	IOSK300/1050	28.02.1989	7
H032-C03-503—5032CTC	CT	HAEFELY	IOSK300/1050	28.02.1989	7
H032-C03-503--5038	DISCONNECTOR	EGIC	DR	10.09.1983	2
H032-C03-503--5039	DISCONNECTOR	MORLYNN	HCB	28.02.1989	4

Table 2

ABB HPL300 circuit breaker 5032 is in service for 30 years and started to develop notable gas leaks in 2014 and has been topped up with gas at least once a year since then. There is no on line SF6 leak rate monitoring for this circuit breaker (CB). Powerpatch was applied to try to stop gas leak.

There are 44 circuit breakers of this type in service currently and 18 of these have developed gas leaks at various levels and at least four poles had to be replaced. There are only two spare poles available in stock and refurbishing/repairing these CBs has not proven to be cost effective. The recommended strategy for these ASEA CBs is to replace those that are already leaking and recover good poles of replaced CBs to increase spare holdings to assist in managing others in the fleet.



Figure 6 – 5032- Repair (Belzona) applied



Figure 7 - CB5032

Considering that leaks are slow, but persistent and a number of times this CB has been topped up with SF6 gas, it is expected that condition of this CB will continue to deteriorate and will require high maintenance. Rectification works have been unsuccessful in stopping the leaks and multiple low SF6 alarms have occurred in the past 5 years. Two pole discrepancy trips have also occurred in the previous 5 years which have required rectification works both times. Although replacement is not considered urgent, it is considered to be eminent and therefore it is recommended to replace this CB 5032 in the next 5 years. Considering the fleet of this CBs, the fleet approach should be developed and when prioritisation of this CB replacement, the difficulty of obtaining prolonged outages and network consequence of such outages should be considered.

The Haefely oil filled current transformers (CTs) are in reasonable condition considering they have been in service for 30 years and the DGA/moisture in oil analysis is satisfactory. There are no identified issues with oil seal integrity. Considering their age and the fact these have porcelain housing, leading to a high consequence in case of catastrophic failures, it is recommended to replace these in 5 years. This way the replacement of CTs can be combined with replacement of circuit breaker in this bay, reducing the impact of outage on the network.



Figure 8 –CTs

The two disconnectors 5018 and 5019 installed in this bay are in good condition and maintenance records show some minor corrosion issues associated with these and 5018 has also had issues with the open contactor coil which has had to be replaced. It is believed that in the next 10-20 years some refurbishment maybe required on these. All high voltage equipment insulators in this bay have dirt or fungus that should be removed.

The associated structures and foundations are in good condition and are expected to last for another 20 years.

Recommendation: Based on the above observations, it is recommended that the CB and CTs incl. structures and foundations are replaced within the next 5 years preferably using dead tank CB.

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

2.2.2 H032-C03-541- 275kV 1 TRANSF BAY

The equipment for this Bay is listed in the Table 3, including a health index value for each item. This bay was augmented in 2002 with addition of new CB and disconnectors under project CP.01402 Ross-Chalumbin 275kV line switching. The 16VT was also replaced in 2021 as part of OR.01581 275kV Trench Replacement project. The only originally installed equipment in this bay are the surge arrestors which have been in service for 35 years.

The equipment installed in 2002 are in good condition. The AEM disconnectors had corroded swivel connection on operating rods, which were replaced with stainless steel units. The CTs in this bay were replaced in 2016 and are in good condition.

The associated structures and foundations are in good condition and are expected to last for another 30 years except for those supporting CVTs & surge arrestors which has a remaining life of 20 years.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-C03-541--16VT	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TCVT300C	16/06/2021	1
H032-C03-541-1SAA	SA (GAPLESS)	ASEA	XAQ300A2	28.02.1989	6
H032-C03-541-1SAB	SA (GAPLESS)	ASEA	XAQ300A2	28.02.1989	6
H032-C03-541-1SAC	SA (GAPLESS)	ASEA	XAQ300A2	28.02.1989	6
H032-C03-541--5410	EARTH SWITCH	AEM AUSTRALIA	SE362	02.04.2002	2
H032-C03-541--5410-1	EARTH SWITCH	AEM AUSTRALIA	SE362	02.04.2002	2
H032-C03-541--5410-2	EARTH SWITCH	AEM AUSTRALIA	SE362	02.04.2002	2
H032-C03-541--5410-3	EARTH SWITCH	AEM AUSTRALIA	SE362	02.04.2002	2
H032-C03-541--5411	DISCONNECTOR	AEM AUSTRALIA	DB362	02.04.2002	2
H032-C03-541--5412	CIRCUIT BREAKER	SIEMENS	3AP1-F1-300kV	02.04.2002	4

H032-C03-541--TRFCTA	CT	ABB	IMB300C5H3	17.06.2016	7
H032-C03-541--TRFCTB	CT	ABB	IMB300C5H3	17.06.2016	7
H032-C03-541--TRFCTC	CT	ABB	IMB300C5H3	17.06.2016	7
H032-C03-541--5413	DISCONNECTOR	AEM AUSTRALIA	DB362	02.04.2002	2
H032-C03-541--5417	DISCONNECTOR	AEM AUSTRALIA	DB362	02.04.2002	2

Table 3 –Bay C03- 541 Equipment

The surge arrestors are in good condition but are not tested to the current standards and do not provide adequate protection for the equipment in this bay. Therefore these should be replaced at the same time as IMB300 CTs to make it more cost effective and reducing outages impact on the network and customers.

The earth switches 5410 and 5410-1 and isolators 5411 and 5417 all had corrosion rust through that required replacement of their impacted parts. Earth switch 5410-3 had a gear box leak develop which required rectification.

As such these should be replaced within the next 5 years to minimise the risk that they pose. Currently the DGA and moisture test have assessed these as being satisfactory.

Recommendation: Based on the above observations, the primary plant in this bay is in good condition and only replacement of CTs and SAs is recommended to be replaced in the next 5 years.

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

2.2.3 H032-C03-857 – 857 Feeder

The equipment for this Bay is listed in the Table 4, including a health index value for each item. This bay consists of equipment related to F857 and the equipment associated with feeder reactor.

The original equipment comprising disconnector 8579 and surge arrestors were installed in early to mid-1989 and have been in service for 30 years.

This bay was augmented in 2006 with addition of new CBs and disconnectors under project CP.01402 Ross-Chalumbin 275kV line switching.

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

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-C03-857--1VTA	CVT	TRENCH LIMITED	TEMP287	31.07.2001	6
H032-C03-857--1VTB	CVT	TRENCH LIMITED	TEMP287	31.07.2001	6
H032-C03-857--1VTC	CVT	TRENCH LIMITED	TEMP287	31.07.2001	6
H032-C03-857--2VTB	CVT	TRENCH LIMITED	TEMP287	08.05.2006	6
H032-C03-857--8570	EARTH SWITCH	ABB	ES300	08.05.2006	2

H032-C03-857--8570-1	EARTH SWITCH	ABB	ES300	08.05.2006	2
H032-C03-857--8570-2	EARTH SWITCH	ABB	ES300	08.05.2006	2
H032-C03-857--8570-3	EARTH SWITCH	ABB	ES300	08.05.2006	2
H032-C03-857--8570-4	EARTH SWITCH	MORLYNN	VSB	28.02.1989	5
H032-C03-857--8501	DISCONNECTOR	ABB	DBRP 300	08.05.2006	3
	CIRCUIT BREAKER	ABB, SWEDEN	HPL300B1 SPAR	08.05.2006	4
H032-C03-857--8572-1	CIRCUIT BREAKER	ABB, SWEDEN	HPL300B1 SPAR	17.06.2016	3
H032-C03-857--8577	DISCONNECTOR	ABB	DBRP 300	08.05.2006	3
H032-C03-857--8579	DISCONNECTOR	MORLYNN	VSB	28.02.1989	5
H032-C03-857--857CTA	CT	ARTECHE	CA300	10.12.2004	4
H032-C03-857--857CTB	CT	ARTECHE	CA300	10.12.2004	4
H032-C03-857--87CTC	CT	ARTECHE	CA300	10.12.2004	4
H032-C03-857--857CDB	COUPLING DEVICE	TRENCH ELECTRIC	K9514XS	16.12.2005	9
H032-C03-857--857CDC	COUPLING DEVICE	TRENCH ELECTRIC	K9514XS	16.12.2005	9
H032-C03-857--8503	DISCONNECTOR	ABB	DBRP 300	08.05.2006	2
H032-C03-857--8507	DISCONNECTOR	ABB	DBRP 300	08.05.2006	2
H032-C03-857--857RESAA	SA (GAPLESS)	ABB	XAQ300A2	28.02.1989	7
H032-C03-857--857RESAB	SA (GAPLESS)	ABB	XAQ300A2	28.02.1989	7
H032-C03-857--857RESAC	SA (GAPLESS)	ABB	XAQ300A2	28.02.1989	7
H032-C03-857--857SAA	SA (GAPLESS)	ABB	XAQ300A2	28.02.1989	7
H032-C03-857--857SAB	SA (GAPLESS)	ABB	XAQ300A2	28.02.1989	7
H032-C03-857--857SAC	SA (GAPLESS)	ABB	XAQ300A2	28.02.1989	7

Table 4 – Bay C03-857 Equipment

All the equipment in this bay are in good condition. Maintenance records indicate that in 2016 the entire pole of CB 8572-1 had to be replaced. Whilst the pole was replaced in 2016, the year of manufacture of this CB indicates that it is 26 years old. In either case, it should not be necessary to have it replaced in the next 10 years. Circuit breaker 8572 also had a spring charge timer fault that required replacement in 2024.

The CVT models installed in this bay are the defective Trench models and should be replaced within the next 5 years. The surge arrestors are nearing the end of their technical design life and should be replaced at the same time as the CVTs.

The associated structures and foundations are in good condition and are expected to last for another 30 years except for disconnectors 8579 and circuit breaker 8572-1, which all have a remaining service life of 15-20 years.

Recommendation: Based on the above observations, the primary plant in this bay is in good condition and no replacements are required in the next 10 year outlook aside from the CVTs and surge arrestors. It is recommended to also rearrange the two coupling devices which are redundant to ensure their failure does not result in loss of CVTs earthing. Although their start-up date in 2005 these have been manufactured in 1989.

It is recommended to continue monitoring condition of structures and foundations in this bay for another 10-15 years (if not replaced with the equipment) and plan their replacement in 15-20 years along the circuit breaker 8572-1.

2.2.4 **H032-C04-504 - 275kV 4 Coupler Bay**

The equipment for this Bay is listed in the Table 5, including a health index value for each item.

This bay was established in 1993 and the only original equipment remaining are the Merlin Gerin disconnectors and associated earth switches.

The circuit breaker was installed in 2015 and the SF6 CTs were installed in 2014 as a part of ABB twin leg CT replacement project. It is noted that this coupler bay has CTs installed only on one side of CB.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-C04-504--5040-1	EARTH SWITCH	MERLIN GERIN		10.09.1993	3.
H032-C04-504--5040-2	EARTH SWITCH	MERLIN GERIN		10.09.1993	2
H032-C04-504—5042	CIRCUIT BREAKER	ABB	HPL300/25B1	19.08.2015	4
H032-C04-504—5042CTA	CT	TRENCH	SAS300/2G	31.08.2014	3
H032-C04-504—5042CTB	CT	TRENCH	SAS300/2G	31.08.2014	3
H032-C04-504—5042CTC	CT	TRENCH	SAS300/2G	31.08.2014	3
H032-C04-504—5048	DISCONNECTOR	MERLIN GERIN	DR	10.09.1993	2
H032-C04-504—5049	DISCONNECTOR	MERLIN GERIN	DR	10.09.1993	6

Table 5 – C04-504 Equipment

All the equipment in this bay are in reasonable condition. Circuit Breaker 5042 required replacement of the seal in 2021 however this seems to have been effective in stopping the SF6 leak as no further loss of SF6 has been reported. Isolator 5048 was also unable to be electrically operated which required replacement of the defective parts.

The associated structures and foundations are in good condition and are expected to last for another 40 years for CB and CTs and another 30 years for the rest of the equipment.

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

It is recommended to continue monitoring condition of structures and foundations in this bay for another 10-15 years (if not replaced with the equipment) and plan their replacement in 30-40 years.

2.2.5 **H032-C04-858 – 858 Feeder**

The equipment for this Bay is listed in the Table 6, including a health index value for each item. This bay consists of equipment associated with switching of F858 and of equipment associated with switching of feeder reactor.

This bay was built in 1993 and was augmented in 2003 with addition of new CBs and disconnectors under project CP.01402 Ross-Chalumbin 275kV line switching

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-C04-858--5VTA	CVT	TRENCH LIMITED	TCVT300C	02.09.2016	3
H032-C04-858--5VTB	CVT	TRENCH LIMITED	TCVT300C	02.09.2016	3
H032-C04-858--5VTC	CVT	TRENCH LIMITED	TCVT300C	02.09.2016	3
H032-C04-858--9VTB	CVT	TRENCH LIMITED	TEMP287	08.05.2006	7
H032-C04-858--8580	EARTH SWITCH	ABB	ES300	08.12.2003	4
H032-C04-858--8580-1	EARTH SWITCH	ABB	ES300	08.12.2003	4
H032-C04-858--8580-2	EARTH SWITCH	ABB	ES300	08.12.2003	4
H032-C04-858--8580-3	EARTH SWITCH	ABB	ES300	08.12.2003	4
H032-C04-858--8580-4	EARTH SWITCH	MERLIN GERIN		28.02.1993	4
H032-C04-858--8581	DISCONNECTOR	ABB	DBRP 300	08.12.2003	4
H032-C04-858--8582	CIRCUIT BREAKER	ABB, SWEDEN	HPL300B1 SPAR	08.12.2003	5
H032-C04-858--8582-1	CIRCUIT BREAKER	ABB, SWEDEN	HPL300B1 SPAR	31/03/2023	1
H032-C04-858--8587	DISCONNECTOR	ABB	DBRP 300	08.12.2003	4
H032-C04-858--8589	DISCONNECTOR	MERLIN GERIN	VSB	28.02.1993	4
H032-C04-858--858CTA	CT	ARTECHE	CA300	10.12.2004	4
H032-C04-858--858CTB	CT	ARTECHE	CA300	10.12.2004	4
H032-C04-858--858CTC	CT	ARTECHE	CA300	10.12.2004	4
H032-C04-858--858RESAA	SA (GAPLESS)	ABB	EXLIM Q240	10.09.1993	4
H032-C04-858--858RESAB	SA (GAPLESS)	ABB	EXLIM Q240	10.09.1993	4
H032-C04-858--858RESAC	SA (GAPLESS)	ABB	EXLIM Q240	10.09.1993	4
H032-C04-858--858SAA	SA (GAPLESS)	ABB	EXLIM Q240	10.09.1993	4
H032-C04-858--858SAB	SA (GAPLESS)	ABB	EXLIM Q240	10.09.1993	4
H032-C04-858--858SAC	SA (GAPLESS)	ABB	EXLIM Q240	10.09.1993	4

Table 6 – C04-858 Bay equipment

ABB HPL300 Reactor Circuit Breaker 8582-1 is in service for 2 years and has no issues reported.

The isolators 8587 and 8589 has had corrosion noticed which still requires rectification. Isolator 8589 also could not be electrically operated and the isolator motor required replacement.

The 858--9 CVT installed in this bay has since been identified to be a defective model and should be replaced within the next 5 years.

The surge arrestors are in good condition but are not tested to the current standards and do not provide adequate protection for the equipment in this bay. Therefore

these should be replaced at the same time as Trench CVTs to make it more cost effective and reducing outages impact on the network and customers.

All the other equipment in this bay is in good condition. Maintenance records does not show any major issues with the equipment in this bay apart from 858-9VTB. The associated structures and foundations are in good condition and are expected to last at least another 20 years.

Recommendation: Based on the above observations, the primary plant in this bay is in good condition and only replacement of 858—9 VT and surge arrestors is required in the next 10 year outlook.

It is recommended to continue monitoring condition of structures and foundations in this bay for another 10-15 years (if not replaced with the equipment) and plan their replacement in 20-30 years. It is expected that 8582 circuit breaker in this bay will not develop gas leaks due to no history present of it occurring. This should continue to be monitored however.

2.2.6 H032-C06-8932 – 8932 Feeder

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

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-C06-8932-13VTA	CVT	ASEA	CPEE300F-C	11.08.1997	8
H032-C06-8932-13VTB	CVT	ASEA	CPEE300F-C	11.08.1997	8
H032-C06-8932-13VTC	CVT	ASEA	CPEE300F-C	11.08.1997	8
H032-C06-8932-18VTB	CVT	TRENCH LIMITED	TEMP287	04.10.2004	7
H032-C06-8932-8932	EARTH SWITCH	ABB	ES300	04.10.2004	3
H032-C06-8932—8932-1	EARTH SWITCH	ABB	ES300	04.10.2004	3
H032-C06-8932—8932-2	EARTH SWITCH	ABB	ES300	30.09.2002	3
H032-C06-8932—8932-3	EARTH SWITCH	ABB	ES300	04.10.2004	3
H032-C06-8932—8932	DISCONNECTOR	ABB	DBRP 300	04.10.2004	3
H032-C06-8932—8932	CIRCUIT BREAKER	ABB, SWEDEN	HPL300B1 SPAR	07.11.2003	4
H032-C06-8932—8932	DISCONNECTOR	ABB	DBRP 300	30.09.2002	3
H032-C06-8932—8932	DISCONNECTOR	ABB	DBRP 300	04.10.2004	3
H032-C06-8932-8932CTA	CT	ARTECHE	CA300	10.12.2004	4
H032-C06-8932--8932CTB	CT	ARTECHE	CA300	10.12.2004	4
H032-C06-8932-8932CTC	CT	ARTECHE	CA300	10.12.2004	4

Table 7- C06-877 Bay Equipment

Although this bay was built in 2004, according to SAP records all three CVTs across the 3 phases in this bay have been manufactured in 1981. It seems that these were issued from warehouse and installed in 2004 at this site. This means that their

service age is 20 years and nameplate age is 33 years. Apart from dark oil colour which was attributed to the type of sight glass, maintenance records does not show any other major condition issues related to the equipment in this bay. The specific ASEA CPEE300F-C CVT model has had an issue noticed and shared to Powerlink regarding increased likelihood to explode during over voltages. Due to the porcelain bushing housing this poses a significant to anyone within the explosive vicinity.

The 8932-18VTB Trench CVT installed in this bay has also been identified to be a defective model with an increased likelihood of failure and is recommended to be replaced.

In 2018 the circuit breaker suffered restrike after lightning storm during auto-reclose and flashover marks were noted across palms of B phase. It's condition should be closely monitored.

The associated structures and foundations are in good condition and are expected to have a remaining life 30 years

Recommendation: Based on the above observations, it is recommended that all four CVTs are replaced within the next 5 year outlook. The other primary plant in this bay is in good condition and no replacements are required in the next 10 year outlook.

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

2.2.7 **H032-D03-411 - 132kV 1-2 BUS SECTION BAY**

The equipment for this Bay is listed in the table below, including a health index value for each item. This bay was installed in 1996, and all of the original equipment is still in service.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-D03-411--1BUSCTA	CURRENT TRANSFORMER	ABB	169869	2/09/1996	4
H032-D03-411--1BUSCTB	CURRENT TRANSFORMER	ABB	169869	2/09/1996	4
H032-D03-411--1BUSCTC	CURRENT TRANSFORMER	ABB	169869	2/09/1996	4
H032-D03-411--2BUSCTA	CURRENT TRANSFORMER	ABB	169869	2/09/1996	4
H032-D03-411--2BUSCTB	CURRENT TRANSFORMER	ABB	169869	2/09/1996	4
H032-D03-411--2BUSCTC	CURRENT TRANSFORMER	ABB	169869	2/09/1996	4
H032-D03-411--4112	CIRCUIT BREAKER	AEG	S1-145F1 3PAR P	23/08/1996	8
H032-D03-411--4117	ISOLATOR	STANGER	HDBC	2/09/1996	3
H032-D03-411--4118	ISOLATOR	STANGER	RDB	2/09/1996	3

The circuit breaker in this bay has had a history of SF6 leaks originating from the dashpot along with the dashpot not operating correctly. This dashpot is unable to be replaced as the manufacturer does not provide a support/system to complete these

works. This is resulting in very harsh and violent operation. It is recommended that this circuit breaker is replaced in the next 5 years.

The current transformers have had some minor oil leaks that required rectification however these are considered to be in good condition for their age. However, these are oil paper current transformers with porcelain housing and after 30-35 years tend to develop catastrophic failure modes likely attributed to the exposure of insulation to electric field and present potential high safety risk for personnel. Therefore, these should be preventively replaced along the circuit breaker in this bay.

Both isolators have had some minor corrosion reported however these are also considered to be in good condition for their age.

Recommendations: It is recommended that the circuit breaker and current transformers are replaced within the next 5 years, taking opportunity to use dead tank CB and further reduce a number of post type CTs in the network. The other equipment in this bay is considered to be in good condition and no replacement is expected to be needed within the next 10 year outlook.

2.2.8 ***H032-D04-441- 132kV 1 Transformer Bay***

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

This bay was built in 1989 and most of high voltage equipment have been in service for 30 years. The 3VTA and 3VTB CVTs in this bay were replaced in 2024 as part of an ETR project due to the discolouration of there oil.

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

The insulator sheds of all the primary in this bay has mould which requires cleaning, this mould is due to the tropical weather condition in FNQ region.

The Tyree oil filled current transformers are in reasonable condition considering they have been in service for 35 years and the DGA/moisture in oil analysis is satisfactory. According to the maintenance records, there are no identified issues with oil seals integrity. Considering their age and housing material being porcelain and the potential safety impact of their catastrophic failure, it is recommended to replace these in 5 years. Current transformers with paper and oil have an increased probability of explosive failure occurring after 36 years in service. It is recommended to replace these CTs in the next 5 years.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-D04-441-1SAA	SA	ASEA	XAR145A2	28.02.1989	6
H032-D04-441-1SAB	SA	ASEA	XAR145A2	28.02.1989	6
H032-D04-441-1SAC	SA	ASEA	XAR145A2	28.02.1989	6
H032-D04-441-4410	EARTH SWITCH	SIEMENS	SSBIII-AMB145	28.02.1989	4
H032-D04-441-4412	CIRCUIT BREAKER	ASEA	HLR145/2501E	28.02.1989	8
H032-D04-441-4413	DISCONNECTOR	WESTRALIAN	DBR132	28.02.1989	4
H032-D04-441-1TRFCTA	CT	TYREE	06/145/50	28.02.1989	8
H032-D04-441-1TRFCTB	CT	TYREE	06/145/50	28.02.1989	8

H032-D04-441-1TRFCTC	CT	TYREE	06/145/50	28.02.1989	8
H032-D04-441-3VTA	CVT	GE GRID SOLUTIONS INDIA	CCV 170	23/02/2024	1
H032-D04-441-3VTB	CVT	GE GRID SOLUTIONS INDIA	CCV 170	23/02/2024	1
H032-D04-441-3VTC	CVT	TRENCH	TCVT145C	24.04.2015	2

Table 8 –Bay D04-441 Equipment

Considering the age of the CTs in this bay and due to the possible safety risk associated with the porcelain housed oil type configuration that is present it is recommended to replace these within the next 5 years.

In addition, the circuit breaker in this bay is a minimum oil circuit breaker containing 165 kg of oil rated for 2000 operations (according to SAP record had done only 155 operations). Although it is in good condition for its age, it is recommended to replace it within next 5-10 years to reduce presence of oil and to enable installation of dead tank circuit breaker to reduce maintenance associated with current transformers. Dead tank circuit breakers contain toroidal CTs which are maintenance free.



Figure 9 – HLR Circuit Breaker

Recommendation: Based on the above observations, it is recommended that the CTs and CB, inclusive of structures and foundations are replaced within the next 5 years using dead tank circuit breaker. In addition to this the Surge Arrestors should also be replaced as they are reaching their end of technical design life.

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

2.2.9 **H032-D05-7191 – 7191 Feeder Bay**

The equipment for this bay is listed in the table below, including a health index value for each item. This bay was installed in 1996 with all original equipment still in service except for the VTs which were replaced in 2023 due to A phase failing and the other phases being replaced at the same time due to being defective.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-D05-7191-71910	EARTH SWITCH	STANGER	KLR	23/09/1996	4
H032-D05-7191-71911	ISOLATOR	STANGER	HDBC	2/09/1996	3
H032-D05-7191-71912	CIRCUIT BREAKER	AEG	S1-145F1 3PAR P	23/08/1996	8
H032-D05-7191-71913	ISOLATOR	STANGER	HDBC	2/09/1996	3
H032-D05-7191-7191CTA	CURRENT TRANSFORMER	ABB	169869	2/09/1996	5
H032-D05-7191-7191CTB	CURRENT TRANSFORMER	ABB	169869	2/09/1996	5
H032-D05-7191-7191CTC	CURRENT TRANSFORMER	ABB	169869	2/09/1996	5
H032-D05-7191-7191SAA	SURGE ARRESTOR (GAPLESS)	ABB POWER TRANSMISSION	EXLIM R120-AM145M	23/08/1996	3
H032-D05-7191-7191SAB	SURGE ARRESTOR (GAPLESS)	ABB POWER TRANSMISSION	EXLIM R120-AM145M	23/08/1996	3
H032-D05-7191-7191SAC	SURGE ARRESTOR (GAPLESS)	ABB POWER TRANSMISSION	EXLIM R120-AM145M	23/08/1996	3
H032-D05-7191-7VTA	CAPACITOR VOLTAGE TRANSFORMER	GE GRID SOLUTIONS INDIA	CCV 170	8/09/2023	1
H032-D05-7191-7VTB	CAPACITOR VOLTAGE TRANSFORMER	GE GRID SOLUTIONS INDIA	CCV 170	29/11/2023	1
H032-D05-7191-7VTC	CAPACITOR VOLTAGE TRANSFORMER	GE GRID SOLUTIONS INDIA	CCV 170	29/11/2023	1

The circuit breaker in this bay has had a history of SF6 leaks originating from the dashpot along with the dashpot not operating correctly. This dashpot is unable to be replaced as the manufacturer does not provide a support/system to complete these works. This is resulting in very harsh and violent operation. It is recommended that this circuit breaker is replaced in the next 5 years.

The earth switch 71910 and isolator 71913 have had some history of corrosion though both are considered to be in good condition.

All current transformers test results are considered satisfactory. The current transformers have had some minor oil leaks that required rectification however these are considered to be in good condition for their age. However, these are oil paper current transformers with porcelain housing and after 30-35 years tend to develop catastrophic failure modes likely attributed to the exposure of insulation to electric field and present potential high safety risk for personnel. Therefore, these should be preventively replaced along the circuit breaker in this bay.

Recommendations: It is recommended that the circuit breaker and CTs are replaced within 5 years. All other equipment is considered to be in good condition and does not require replacement in the next 10 year outlook.

2.2.10 **H032-D06-442 - 132kV 2 TRANSF BAY**

The equipment for this bay is listed in the table below, including a health index value for each item. This bay was built in 1997, and all of the original equipment is still in service.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-D06-442--2SAA	SURGE ARRESTOR (GAPLESS)	ABB POWER TRANSMISSION	EXLIM R120-AM145M	25/11/1997	4
H032-D06-442--2SAB	SURGE ARRESTOR (GAPLESS)	ABB POWER TRANSMISSION	EXLIM R120-AM145M	25/11/1997	4
H032-D06-442--2SAC	SURGE ARRESTOR (GAPLESS)	ABB POWER TRANSMISSION	EXLIM R120-AM145M	25/11/1997	4
H032-D06-442--2TRFCTA	CURRENT TRANSFORMER	ABB	169869	25/11/1997	5
H032-D06-442--2TRFCTB	CURRENT TRANSFORMER	ABB	169869	25/11/1997	5
H032-D06-442--2TRFCTC	CURRENT TRANSFORMER	ABB	169869	25/11/1997	5
H032-D06-442--10VTA	CAPACITOR VOLTAGE TRANSFORMER	EMEK ELEKTRIK	KGT-145	25/11/1997	5
H032-D06-442--10VTB	CAPACITOR VOLTAGE TRANSFORMER	EMEK ELEKTRIK	KGT-145	25/11/1997	5
H032-D06-442--10VTC	CAPACITOR VOLTAGE TRANSFORMER	EMEK ELEKTRIK	KGT-145	25/11/1997	5
H032-D06-442--4422	CIRCUIT BREAKER	AEG	S1-145F1 3PARP	25/11/1997	8
H032-D06-442--4420	EARTH SWITCH	STANGER	KLR	31/12/1997	3
H032-D06-442--4423	ISOLATOR	STANGER	RDB	31/12/1997	3

The circuit breaker in this bay has had a history of SF6 leaks originating from the dashpot along with the dashpot not operating correctly. This dashpot is unable to be replaced as the manufacturer does not provide a support/system to complete these works. This is resulting in very harsh and violent operation. It is recommended that this circuit breaker is replaced in the next 5 years.

There has been some corrosion noticed on the isolator, earth switch and VTs, however this has all been rectified and has been considered successful with no further defects raised.

The CTs have had one high moisture reading in 2004, however this high result has not been repeated since and all oil test results have since been satisfactory. However, these are oil paper current transformers with porcelain housing and after 30-35 years tend to develop catastrophic failure modes likely attributed to the exposure of insulation to electric field and present potential high safety risk for personnel. Therefore, these should be preventively replaced along the circuit breaker in this bay.

Recommendation: It is recommended that the circuit breaker and CTs are replaced within the next 5 years due to the known defects with this model. All of the other equipment in this bay is in good condition and is expected to not require replacement within the next 10 year outlook.

2.2.11 **H032-D06-7192 - 7192 Feeder Bay**

The equipment for this Bay is listed in Table 9, including a health index value for each item.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-D06-7192--2SAA	SA (GAPLESS)	ASEA	XAR145A2	28.02.1989	7
H032-D06-7192--2SAB	SA (GAPLESS)	ASEA	XAR145A2	28.02.1989	7
H032-D06-7192--2SAC	SA (GAPLESS)	ASEA	XAR145A2	28.02.1989	7
H032-D06-7192—7192CTA	CT	ABB	IMBM145	30.04.2005	2
H032-D06-7192—7192CTB	CT	TYREE	06/145/56	28.02.1989	7
H032-D06-7192—7192CTC	CT	TYREE	06/145/56	28.02.1989	7
H032-D06-7192—6VTA	CVT	TRENCH	TCVT145	03.04.2015	2
H032-D06-7192—6VTB	CVT	TRENCH	TCVT145	03.04.2015	2
H032-D06-7192—6VTC	CVT	TRENCH	TCVT145	03.04.2015	2
H032-D06-7192--71920	EARTH SWITCH	WESTRALIAN	KLR	28.02.1989	4
H032-D06-7192--71922	CIRCUIT BREAKER	ASEA	HLR145	21.02.1989	7
H032-D06-7192--71920	DISCONNECTOR	WESTRALIAN	DBRP132	28.02.1989	4
H032-D06-7192--71923	DISCONNECTOR	WESTRALIAN	DBRP132	28.02.1989	4

Table 9- Bay H032-D06-7192 Equipment

This bay was established in 1989, majority of high voltage equipment in this bay are in service for just over 30 years. The circuit breaker is minimum oil filled circuit breaker having issues with the operations counter and spring charge motor. It is recommended to replace within the next 10 years period as it is expected to develop more issues. The similar applies to two Tyree CTs, especially considering their age and the fact these have porcelain housing and therefore the safety consequence of their potential catastrophic failures could be significant. IMBM145 CTs have increased failure rate and therefore these CT should also be replaced. All three CVTs failed in service and were replaced in 2015. In addition there is a well-developed corrosion of various parts of earth switches and disconnectors.

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

Recommendation: Based on the above observations, it is recommended to replace the CB and all three CTs with dead tank circuit breaker inclusive of structures and foundations in 5 years' time. Consider refurbishment requirements for earth switches and disconnectors. It is prudent due to their age and technical design life to also replace the surge arresters during the same period.

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

2.2.12 H032-D07-7166 - 132kV Feeder Bay

The equipment for this Bay is listed in Table 10, including a health index value for each item.

This bay was established in 1989, so majority of the high voltage equipment in this bay have been in service for just over 30 years. In 2015, the small oil leak was noticed from circuit breaker and few smaller parts of it had to be replaced, indicating that aging process has started. In addition there is a well-developed corrosion of various parts of earth switches and disconnectors. In 2016 all three CVTs failed in service (high moisture content in base box) and were replaced using CVTs manufactured in 2008. As obvious from Figure 11 A phase has bottom of base tank heavily corroded. It is presumed that tank is made of aluminium so the source of corrosion could be hold down bolts.

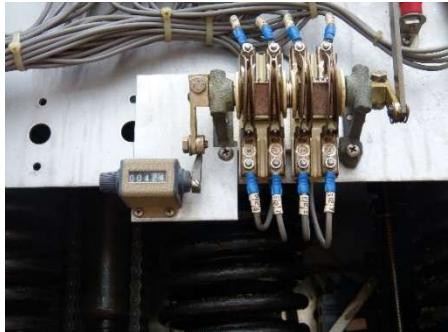


Figure 10– CB71662



Figure 11 - CVT corrosion

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-D07-7166--7166SAA	SA (GAPLESS)	ASEA	XAR145A2	28.02.1989	7
H032-D07-7166--7166SAB	SA (GAPLESS)	ASEA	XAR145A2	28.02.1989	7
H032-D07-7166--7166SAC	SA (GAPLESS)	ASEA	XAR145A2	28.02.1989	7
H032-D07-7166—7166CTA	CT	TYREE	06/145/56	28.02.1989	7
H032-D07-7166—7166CTB	CT	TYREE	06/145/56	28.02.1989	7
H032-D07-7166—7166CTC	CT	TYREE	06/145/56	28.02.1989	7
H032-D07-7166—4VTA	CVT	TRENCH	TEMP138HC	31.01.2008	7
H032-D07-7166—4VTB	CVT	TRENCH	TEMP138HC	03.04.2015	7

H032-D07-7166—4VTC	CVT	TRENCH	TEMP138HC	03.04.2015	7
H032-D07-7166--71660	EARTH SWITCH	WESTRALIAN	KLR	28.02.1989	5
H032-D07-7166--71662	CIRCUIT BREAKER	ASEA	HLR145	21.02.1989	7
H032-D07-7166--71661	DISCONNECTOR	WESTRALIAN	DBRP132	28.02.1989	5
H032-D07-7166--71663	DISCONNECTOR	WESTRALIAN	DBRP132	28.02.1989	5

Table 10 – Bay H032-D07 Equipment

The three Tyree oil filled current transformers have increasing moisture content in oil samples, possibly indicating aged seals. Considering their age and potential safety consequence in case of catastrophic failure (which is hard to predict based on the available condition monitoring techniques), it is recommended to plan their replacement along with CB in the next 10 years.

The associated structures and foundations are in good condition and are expected to have a remaining life of at least 20-25 years.

Recommendation: Based on the above observations, it is recommended that the CTs and CB inclusive of structures and foundations are replaced within next 5 years using dead tank circuit breaker. Due to the age and technical design life of the surge arresters in this bay it is considered prudent to also replace them at the same time. The CVTs are of the defective Trench model identified and should be replaced in the same period.

It is recommended to continue monitoring condition of structures and foundations in this bay for another 10-15 years (if not replaced with the equipment) and plan their replacement in 20-25 years.

2.2.13 H032-D08-7165 7165 Feeder Bay

The equipment in this bay is listed in the table below, including a health index values for each item. This bay was installed in 1996 with the B phase VT being replaced in 2019 due to failing in service. A and C phase VTs were subsequently replaced in 2024 due to discolouration of the oil in A phase and both models being identified as being defective models.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-D08-7165-71650	EARTH SWITCH	STANGER	KLR	23/09/1996	4
H032-D08-7165-71651	ISOLATOR	STANGER	HDBC	2/09/1996	4
H032-D08-7165-71652	CIRCUIT BREAKER	AEG	S1-145F1 3PAR P	23/08/1996	8
H032-D08-7165-71653	ISOLATOR	STANGER	HDBC	2/09/1996	4
H032-D08-7165-7165CTA	CURRENT TRANSFORMER	ABB	169869	2/09/1996	4
H032-D08-7165-7165CTB	CURRENT TRANSFORMER	ABB	169869	2/09/1996	4
H032-D08-7165-7165CTC	CURRENT TRANSFORMER	ABB	169869	2/09/1996	4
H032-D08-7165-7165SAA	SURGE ARRESTOR (GAPLESS)	ABB POWER TRANSMISSION	EXLIM R120-AM145M	23/08/1996	4
H032-D08-7165-7165SAB	SURGE ARRESTOR (GAPLESS)	ABB POWER TRANSMISSION	EXLIM R120-AM145M	23/08/1996	4
H032-D08-7165-7165SAC	SURGE ARRESTOR (GAPLESS)	ABB POWER TRANSMISSION	EXLIM R120-AM145M	23/08/1996	4

H032-D08-7165-8VTA	CAPACITOR VOLTAGE TRANSFORMER	GE GRID SOLUTIONS INDIA	CCV 170	23/02/2024	1
H032-D08-7165-8VTB	CAPACITOR VOLTAGE TRANSFORMER	TRENCH LIMITED	TCVT145C	11/05/2019	1
H032-D08-7165-8VTC	CAPACITOR VOLTAGE TRANSFORMER	GE GRID SOLUTIONS INDIA	CCV 170	23/02/2024	1

The circuit breaker in this bay has had a history of SF6 leaks originating from the dashpot along with the dashpot not operating correctly. This dashpot is unable to be replaced as the manufacturer does not provide a support/system to complete these works. This is resulting in very harsh and violent operation. It is recommended that this circuit breaker is replaced in the next 5 years.

The isolators 71651 and 71653 have had some history of corrosion however these are considered to be in fair condition for their age and are not expected to be requiring replacement.

The current transformers are in good condition and all oil test results have returned satisfactory. Considering their age and potential safety consequence in case of catastrophic failure (which is hard to predict based on the available condition monitoring techniques), it is recommended to plan their replacement along with CB in the next 5 years.

Due to the age and technical design life of the surge arresters in this bay it is considered prudent to also replace them at the same time.

Recommendations: Based on the above observations it is recommended the circuit breaker, CTs and surge arrestors are replaced within the next 5 years. The other equipment in this bay is in good condition and is not expected to require replacement within the next 10 year outlook.

2.2.14 *H032-F01- 271- 19kV 1 Reactor Bay*

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

All the other equipment is in good condition and maintenance records show no associated problems. It is likely that surge arrestors are not tested to the latest standards and considering their age and these being one of the first generation of ZnO based surge arrestors in porcelain housing, it may be prudent to plan their replacement in next 10 years, assuming the reactor is still required.

The associated structures and foundations in this bay are in good condition and are expected to have a remaining life 25 years.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-F01-271—1SAA	SA	MEIDENSHA	ZSE-C1Z	28.02.1989	6
H032-F01-271—1SAB	SA	MEIDENSHA	ZSE-C1Z	28.02.1989	6
H032-F01-271—1SAC	SA	MEIDENSHA	ZSE-C1Z	28.02.1989	6
H032-F01-271—2711	ISOLATOR	ESSANTEE	67-7470	01.03.1989	4
H032-F01-271—2712	CB	ALSTOM	S1-72.5F1	28.02.1999	5

Table 11- H032-F01 Bay equipment

Although the records do not indicate that circuit breaker was replaced after bay was established based on its manufacturing details, it seems that it is indeed 10 years younger and in good condition.

Recommendation: Based on the above observations, it is recommended to plan replacement of three surge arrestors in next 10 years, assuming the reactor is still required. Please note that the reactor was replaced in 2003 after one phase failed in service.

2.3 Bus Diameters

2.3.1 132kV Bus

As mentioned above there are two 132 kV buses and the equipment associated with these is listed in Table 12, including a health index value for each item.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-KD1-1BU4-4910	EARTH SWITCH	WESTRALIAN		28.062.1989	4
H032-KD2-2BU4-4920	EARTH SWITCH	STANGER	KLR	28.062.1989	3

Table 12 –H032-KD1 and H032-KD2 Bay equipment

The earth switches as well as bus support post insulators are in good condition and the associated structures (predominantly made of tubular steel) and foundations are also in good condition. There is minor corrosion and paint fading on earth switches, which is reasonable to expect the maintenance crews to deal with.

The structures and foundations are estimated have a remaining lives of 25 years.

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

2.3.1 275 kV Bus

The equipment associated with the 275kV bus are listed in Table 13, including a health index value for each item. Similarly to other earth switches, these two also have issues with minor corrosion, paint fainting on flags and high resistance on contacts.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-KC1-1BU5-14VTA	CVT	TRENCH LIMITED	TEMP287	31.12.2003	7
H032-KC1-1BU5-14VTB	CVT	TRENCH LIMITED	TEMP287	31.12.2003	7
H032-KC1-1BU5-14VTC	CVT	TRENCH LIMITED	TEMP287	31.12.2003	7
H032-KC1-1BU5-5910	EARTH SWITCH	ABB	ES300	08.12.2003	2
H032-KC2-2BU5-15VTC	CVT	TRENCH LIMITED	TEMP287	26.08.2004	7
H032-KC2-2BU5-15VTC	CVT	TRENCH LIMITED	TEMP287	26.08.2004	7
H032-KC2-2BU5-15VTC	CVT	TRENCH LIMITED	TEMP287	26.08.2004	7
H032-KC2-2BU5-5920	EARTH SWITCH	AEM AUSTRALIA	SE362	06.09.2002	3

Table 13 – H032-KC1 and H032-KC2 Bay Equipment

The bus support post insulators are in good condition and the associated structures and foundations are in good condition. The structures and foundations in KC1 and Kc2 have an estimated remaining service lives of 25 and 30 years, respectively.

The CVTs in this bay have been identified to be the defective trench models and as such are recommended to be replaced within the next 5 years.

Recommendation: Based on the above observations and condition indicators, it is recommended that the CVTs are replaced within the next 5 years.

2.4 Strung Bus and Structures

Both 132kV and 275kV strung bus conductors and connectors over the bays appear to be in good condition.

As per civil condition assessment report the lattice type towers and beams were found to be in a good condition. The structures and foundations are estimated to have remaining lives of at least 20 years.

The overhead earth wires above all strung buses appear to be in good condition. The connections of the earth wire to their strain towers vary in configuration, the original ones being bolted connection and the later ones compression joints.

2.5 Site Infrastructure

2.5.1 AC supply

The AC supply is via two 19/0.433 kV transformers auxiliary transformers connected to the 11 kV tertiaries of the power transformers 1T and 2T. The setup is shown in figures 13 & 14. These provide adequate and reliable local supply for this substation.

One station transformer was installed in 2003 is pad mounted as per Fig 14. Two Station transformer was installed in 2018 and is pole mounted type as shown in Fig.13.



Figure 12 -2 T station supply transformer



Figure 13 – 1 T station supply transformer

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H032-SIN-ACSU-1STN	LOCAL SUPP TRF	TYREE	MODEL93	05.07.2018	2
H015-SIN-ACSU-2STN	LOCAL SUPP TRF	WILSON	MODEL93	02.01.2003	5

Table 14 – AC supply transformers

2.5.1.1 AC Change overboard

The AC changeover board was replaced under CP.01043 along with the AC distribution boards in 2009 and all appear to be in good condition. During OR.02429 Arc Flash Studies, the ACCO board was calculated to require PPE category 3. To allow for discrimination between the transformer fuse and MCCB within the ACCO board it is recommended that the MCCB settings are lowered. The transformer fuses for the transformer are also recommended to be replaced with T1 having a NH3F-500 fuse installed and T2 having a NH3F-400 fuse installed.

2.5.1.2 Diesel Generator

The diesel generator along with 7 day fuel tank was installed under project CP.01403 in 2009 and appear to be in good condition.

Functional Loc.	Description	Manufacturer	Model number	Start-up date	HI
H015-SIN-DIES-1DIESEL	DIESEL ALTERNATOR	JOHN DEERE / STAMFORD	250 kVA MEGA-GEN	24.07.2009	2

Table 15 – Diesel generator

2.5.2 Security Fence

The substation security fence consists of a standard chain wire fence and an electric fence mounted on the inside of the chain wire fence, installed in 2017. The chain wire fence is approximately 2.4m tall and has a bottom rail and an additional rail at approximately one metre above the ground. It is estimated that both chain wire and electric fence should last until 2032. Then it should be replaced to suit new substation security standard.



Figure 14- Substation gate



Figure 15 –Substation security fence

2.5.3 **Substation Access and Internal Roads and Signage**

The Chalumbin Substation is accessed by a road from town Ravenshoe. The last several kilometres are unsealed. The internal roads are not sealed. While some internal roads are obvious due to difference in the surface colour, other are poorly delineated. It is recommended to rectify this as it may lead to electrical exclusion zones encroachments.

2.5.4 **Substation Yard, Platform and Site Drainage System**

The substation platform is covered in gravel and is generally well maintained. No surface water pooling was observed on the platform. However, identifying any drainage issues was unlikely as the inspection occurred in dry weather.



Figure 16 – Gravel and unmarked internal roadways

2.5.5 **Cable Trenches**

There is no indication in the maintenance records of any issues related to the cable trench covers. The cable ducts and the associated cable covers were in good condition and the covers were neatly placed without significant gaps that could present a tripping hazard.



Figure 17 – Cable trenches

2.5.6 ***Yard Lights***

The 132kV and 275kV switchyard lights are weatherproof low level floodlights. They are in good condition and apart from minor corrosion on holding down bolts no other issues were identified on site.

2.5.7 ***Substation earthing***

2.5.7.1.1 Structure and equipment earthing

The insulated earthing cables have lost their insulation whilst the copper straps above ground level are in good condition. The lowest rated earth tail is suitable to conduct fault current of 27 kA for 500 ms, which is suitable for fault current level for this site.

2.5.7.1.2 Earth grid

Grid injection test was performed in October 2013 and the results were satisfactory- no issues were identified.

3. **OVERVIEW OF RECOMENDATIONS**

Asset	Equip./ comp. replacement Recom. (Y/N)	Refurb./Maintenance Recom. (Y/N)	Comments
H032-D03-411	Y	N	Replace CB & CTs in 5 years Incl. found and str.
H032-D04-441	Y	Y (ESW and ISOL)	Replace SAs, CTs and CB in 5 years. Incl. found and str.
H032-D05-7191	Y	N	Replace CB & CTs in 5 years Incl. found and str.
H032-D06-442	Y	N	Replace CB & CTs in 5 years Incl. found and str.
H032-D06-7192	Y	Y (ESW and ISOL)	Replace SAs, CTs and CB in 5 years. Incl. found and str.
H032-D07-7166	Y	Y (ESW and ISOL)	Replace SAs, CTs and CB in 5 years. Incl. found and str.
H032-D08-7165	Y	N	Replace CB, SAs & CTs in 5 years Incl. found and str.
H032-C03-503	Y	Y (ESW and ISOL)	Replace CTs and CB in 5 years. Incl. found and str.
H032-C03-541	Y	Y (ESW and ISOL)	Replace CTs and SAs with found and str.
H032-C03-857	N	Y (ESW and ISOL)	Replace CVTs, coupling devices and

			SAs with found and str.
H032-C04-504	N	Y (ESW and ISOL)	No replacement in next 10 years.
H032-C04-858	N	Y (ESW and ISOL)	Replace 858-9 CVT, SA's and 8582-1 CB with found and str.
H032-C06-8932	N	Y (ESW and ISOL)	Replace all CVTs with found and str.
H032-F01	Y	Y (ESW and ISOL)	Replace SAs in 10 yrs.
H032-F02	N	Y (ESW and ISOL)	No replacement in next 10 years.
H032-KC1	N	Y (ESW and ISOL)	No replacement in next 10 years.
H032-KC2	N	Y (ESW and ISOL)	Replace CVTs in the next 5 years incl. found and str.
H032-KD1	N	Y (ESW and ISOL)	No replacement in next 10 years.
H032-KD2	N	Y (ESW and ISOL)	No replacement in next 10 years.
Site infrastructure	N		No replacement in next 10 years.

Table 16 – Overview of recommendations

In addition to the above listed please note that:

1. It is recommended for the Planning Team to review the future expected load for the 1-2 Bus Section bay (coupler) for a range of credible contingencies and the bay should be uprated if required.
2. It is recommended for the Planning Team to review the future expected load for the transformers to identify any need to increase the rating of the 132 kV transformer bays (T1 and T2).
3. It is recommended for the Planning Team to review the future expected load for the feeder 876 (presently limited to 1600 A by CT ratio in the feeder bay) to identify any need to increase the rating.
4. It is recommended for the Planning Team to review the future expected load for the 132 kV Bus 1 and Bus 2 (presently limited to 1600 A) for a range of credible contingencies and uprated if required.

3.1 Conclusions

The condition assessment of H032 Chalumbin 275/132kV substation revealed issues related to the condition of some equipment and of some assets. The site was developed and expended over time and a number of equipment failed in service and was replaced through maintenance activities. Whilst the condition of all site was reviewed, the scope of this report was reduced to focus only on the assets established prior to 2001 and having health indices over 4. The recommendations are based purely on condition and the forecast of the condition deterioration expected in the next 10 years. The additional issues taken into account include availability of spares, maintainability of the equipment, potential for significant safety risks and potential for significant damage of adjacent equipment. The

recommendations exclude any consideration given to the enduring need for the assets on this site regardless whether their condition is deteriorated or not. It is believed that recommended replacements or de-energisation of the equipment and assets in deteriorated condition within next 5-10 years would reduce risks to an acceptable level.

4. APPENDICES

Appendix No.1

- Asbestos Register (Objective Id A1999885)

Other reference information

- *Civil condition assessment report (Objective Id A3237809)*.
- *Equipment list (SAP)*
- *Notifications, work orders and measurement documents (SAP)*
- *275kV & 132kV operating diagram*
- *Switchyard earth grid layouts*
- *Equipment, bay and feeder ratings*
- *Discussions with Powerlink technical staff*
- *Discussions with the maintenance service provider*
- *Relevant Powerlink drawings*

4.1 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), by 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 its time in service.

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		

Table 17 – RI Methodology



Document Details				
Version Number	2.0	Principal Author	[Redacted]	
Objective ID	A3245187	Site Visit	25/09/2019	
Issue Date	09/10/2019	Authorised by	[Redacted]	
Previous Document	Version 1.0	Team	Secondary Systems and Telecommunications Strategies	

Date	Version	Nature of Change	Author	Authorisation
07/01/2009	1.0	New document	[Redacted]	[Redacted]
09/10/2019	2.0	Update the whole document	[Redacted]	[Redacted]



Table of Contents

1. Introduction	2
2. Site infrastructure	3
3. Secondary System Assessment Methodology	4
4. Condition Assessment	4
4.1 Buildings	4
4.2 Trench, marshalling cubicles and control cables	7
4.2.1 275kV yard	7
4.2.2 132kV yard	20
4.3 Control and protection bays	31
4.3.1 Protection and control panels	31
4.3.2 275kV Bus zones and couplers	32
4.3.3 275/132kV transformer bays	35
4.3.4 275kV feeder bays	36
4.3.5 275kV Reactors	40
4.3.6 132kV Bus zones and coupler bays	42
4.3.7 132kV feeder bays	44
4.3.8 132kV 1 Capacitor bank	46
4.3.9 19kV Reactor	47
4.3.10 Power System Control and Monitoring	48
4.4 Metering	48
4.5 Non-bays	49
4.5.1 SCADA, Control and OpsWAN	49
4.5.2 Auxiliary supply	53
5. Telecommunication	58
6. Summary of Asset Health	59
7. Conclusion	64
8. References	65

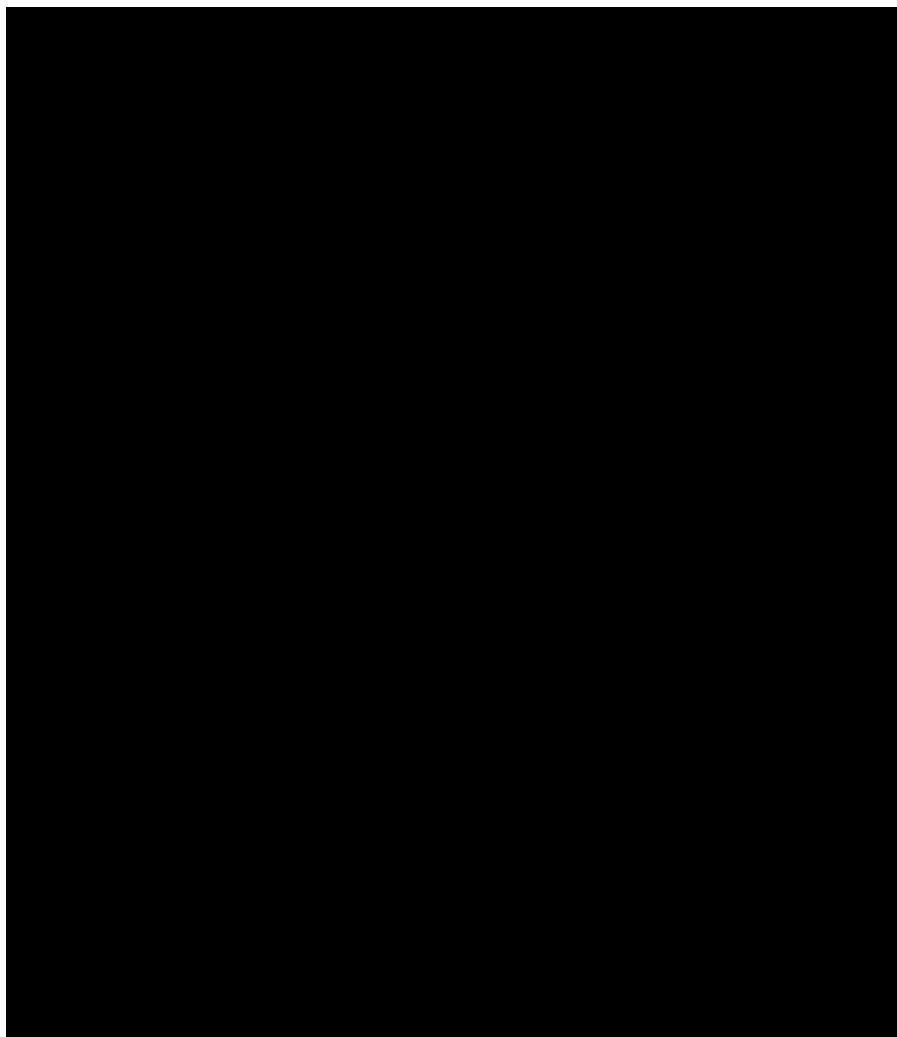


1. Introduction

This report is pertinent to H032 Chalumbin substation 275/132kV secondary systems and associated site infrastructure. The report is provided to assist with determining the future strategy and scope for refurbishment and replacement works of Chalumbin 275kV and 132kV secondary systems equipment.

The assessment has been formulated with the assistance of data extracted from SAP, SPF, Forced Outage Database (FOD), discussion with maintenance staff and a site inspection. Photographs of items are included in the text and all photographs taken during the site visit have been retained for future reference.

H032 Chalumbin substation is an essential 275kV/132kV switching station for feeders into the Cairns and Atherton Tableland areas. The substation was established in 1988. Switchyard augmentation with load growth has resulted a mixer of Secondary systems from 2004 to 2014. Secondary systems for 275kV bus zones, coupler 506, 275kV Feeder 857, 858, 876 and 877 were replaced/refurbished between 2004 and 2007 while secondary systems for all 132kV and partial 275kV including 1 Transformer, 2 Transformer, coupler 503, 504 and 5 Rector were installed/replaced between 2012 and 2014.



H032 Chalumbin operating diagram

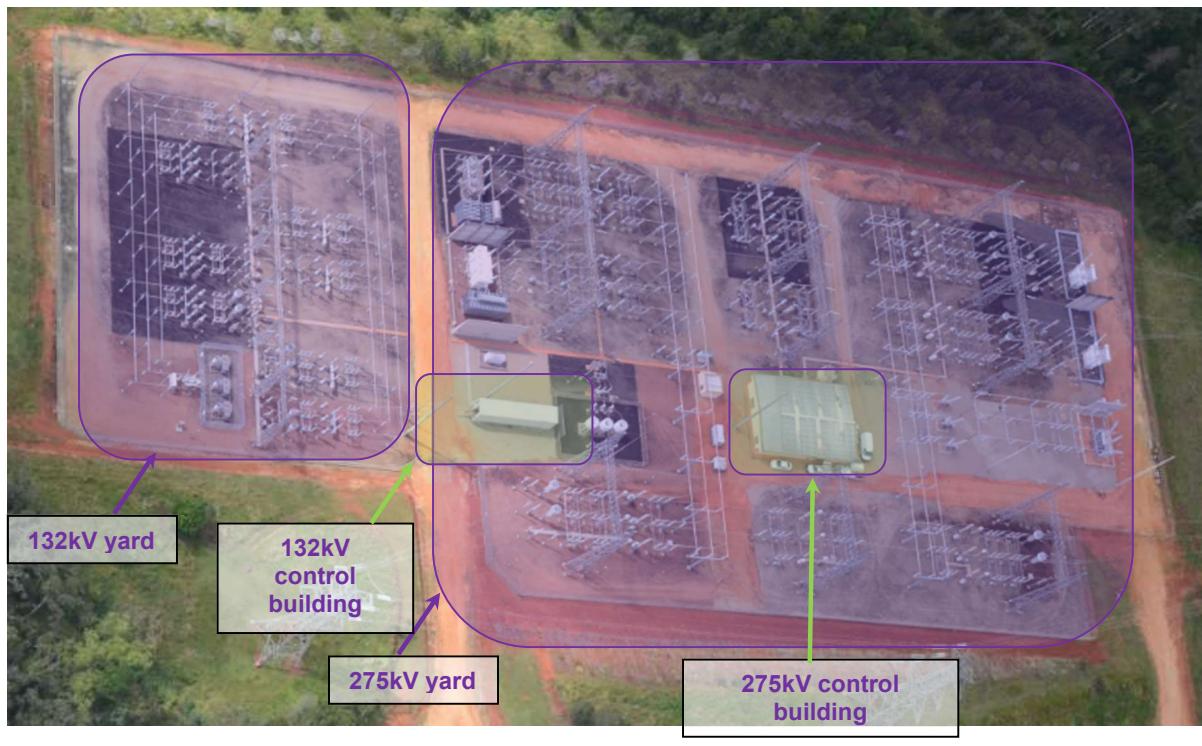
2. Site infrastructure

Chalumbin substation consists of one yard of 275kV and 132kV operating voltage enclosed by the one perimeter fence. The substation was built in 1988. The substation has undergone feeder and bay extensions and modifications since its original construction. This leads to the current installation of secondary systems from 2004 to 2014.

H032 Chalumbin Substation is an essential transmission yard, with:-

- 2 x 275kV bus bays;
- 3 x 275kV bus coupler bays;
- 2 x 275/132kV transformer bays;
- 4 x 275kV feeder bays;
- 1 x 275kV bus reactor bay;
- 2 x 275kV feeder reactor bays;
- 2 x 132kV bus bays;
- 1 x 132kV bus coupler bay;
- 4 x 132kV feeder bays;
- 1 x 132kV Capacitor bank bay
- 1 x 19kV reactor bay.

4 x 275kV feeder bays are energised through Woree and Ross substation. 4 x 132kV feeder bays are connected to Turkinje substation and Kareeya Power Station.



Chalumbin substation yard bird view

The existing Chalumbin substation site is located at south of Ravenshoe off Tully Falls Road. Emergency and routine maintenance of the secondary systems is done by Ergon MSP at the Cairns Depot. Secondary systems are housed in a one level besser block building for 275kV systems and a demountable building for 132kV system adjacent to the switchyard as shown above.



3. Secondary System Assessment Methodology

Secondary systems including protection and control equipment are required to operate the transmission network and prevent any damages to primary systems when adverse events occur. Under the National Electricity Rules, Transmission Network Service Providers are required to provide sufficient secondary systems to ensure the transmission system is protected. A health index of secondary system asset plays an essential role for secondary system reliability, availability and security.

An asset health index rating method has been developed to describe secondary system asset conditions considering:-

- Secondary system equipment functional failure rate
- Operating environment of the secondary system equipment
- Secondary system equipment physical age

Secondary system asset health Index is modelled in the range from a score zero (0) to ten (10), where zero represents new assets and then indicates the asset requires immediate action to address its increasing risk of equipment failure.

The impacts of equipment obsolescence on availability is also considered when determining the recommended replacement actions. This ensures that secondary systems can be returned to service in the event of a failure within sufficient timeframes to meet regulatory requirements.

4. Condition Assessment

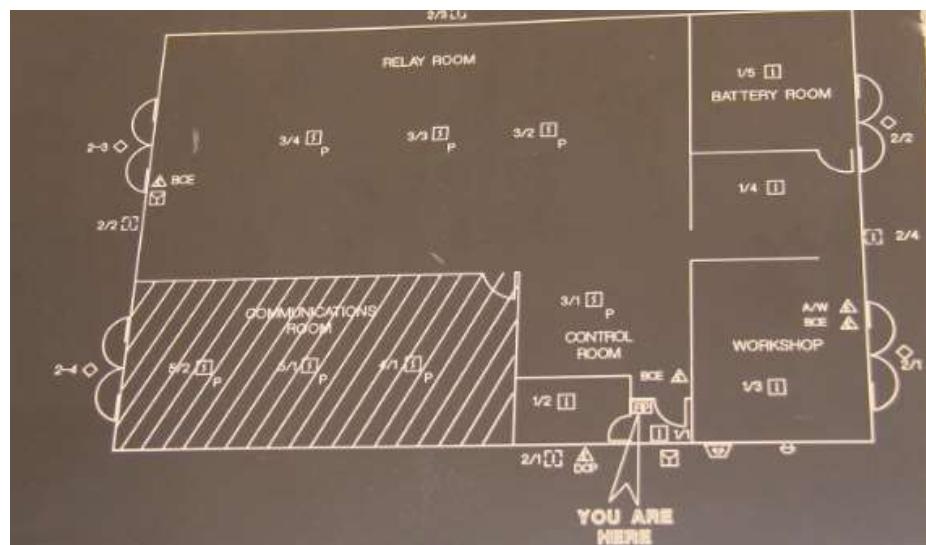
4.1 Buildings

The condition assessment of buildings at H032 Chalumbin is included in a separate document and carried out by Substation Strategies. The following details are for information only.

There are two buildings at H032 Chalumbin, besser block building +1 (including a communication room) and demountable building +4. Building +1 is a one level besser block construction that contains a protection/control room for secondary systems for 275kV network, communication rooms, battery room, and toilet. The building was built in 1988.



Chalumbin control building +1



Control building +1 floor plan

There are plenty of spaces available for future secondary system secondary system replacement or substation augmentation in the existing building +1. This building is air-conditioned.



Building +1 air-conditioner



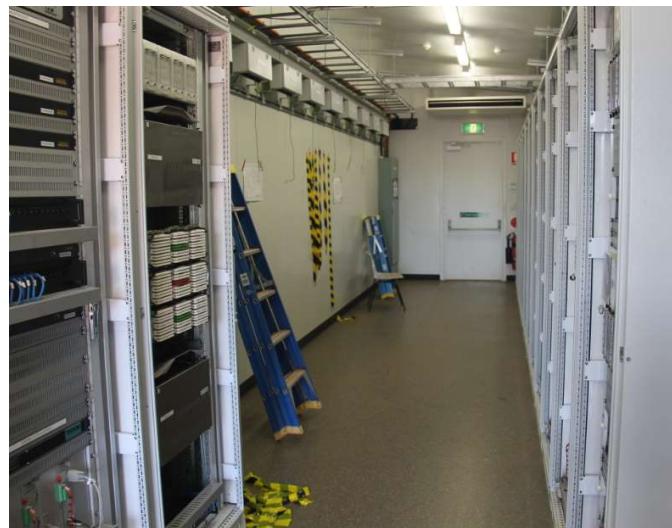
Control building +1 inside

The 132kV demountable building, Building +4 was built in 2012 and is air-conditioned.. It houses all secondary systems for 132kV bays, including 132kV bus zones, feeder 7165, 7166, 755, 7191 and 7192.



Chalumbin control building +4

There are 11 x spare panel spaces in building +4 for future secondary system replacement.



132kV Demountable building +4 inside

4.2 Trench, marshalling cubicles and control cables

Trenches are part of primary assets. Conditions of cable trenches are not included in this report.



Substation trenches

4.2.1 275kV yard

275kV bus marshalling kiosks and VT boxes were installed between 2003 and 2004. Marshalling kiosks and associated control cables are in fair condition. There are no condition driven replacements required until 2043-2044.

**275kV bus 1 CT marshalling kiosk****275kV Bus 2 CT marshalling kiosk**

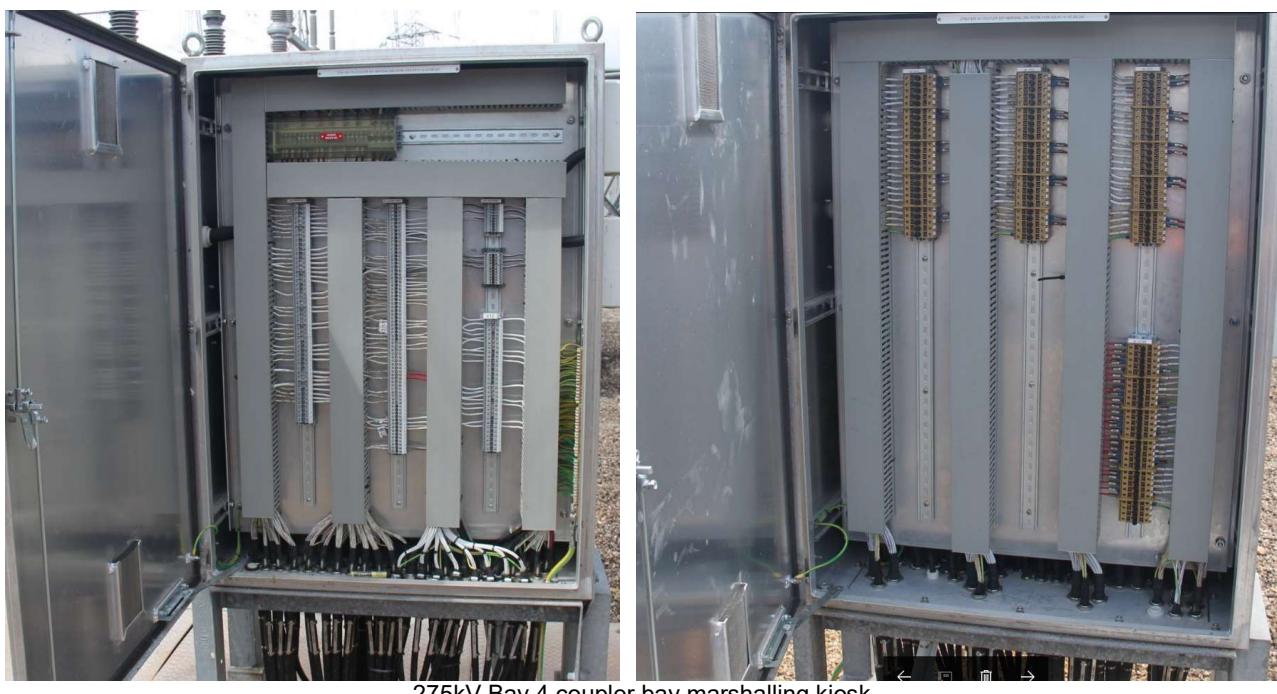


275kV Bus 1 and 2 VT box

Marshalling kiosks for 275kV bus coupler 503 and 504 were replaced under CP.01566 Chalumbin secondary system replacement in 2011. Marshalling kiosks and associated control cables are in good condition. There are no condition driven replacements required until 2051.



275kV Bay 3 coupler bay marshalling kiosk



275kV Bay 4 coupler bay marshalling kiosk

Marshalling kiosk for 275kV bus coupler 506 was installed in 2003. Marshalling kiosks and associated control cables are in fair condition. There are no condition driven replacements required until 2043.



275kV Bay 6 coupler bay marshalling kiosk

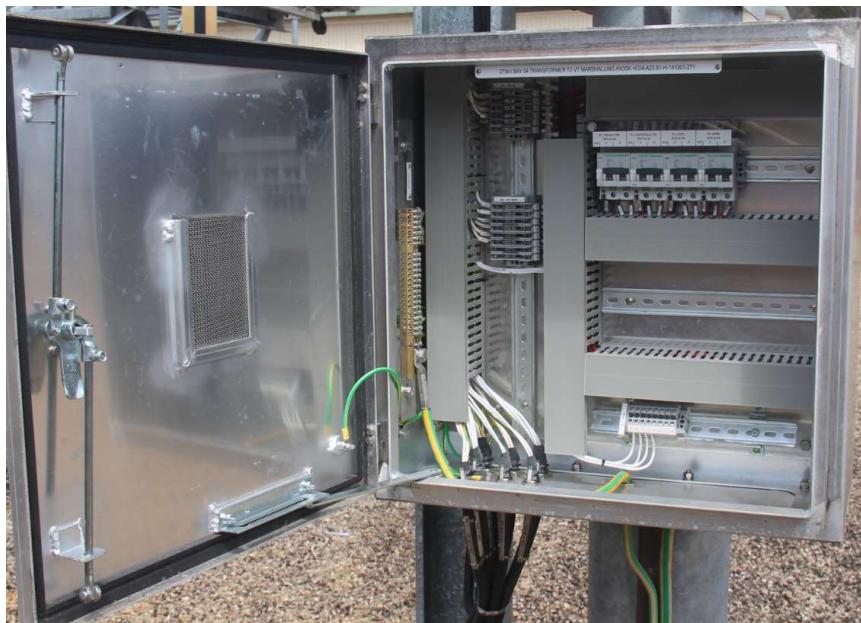
Marshalling kiosks and VT boxes for 275kV 1 and 2 Transformer were replaced under CP.01566 Chalumbin secondary system replacement between 2011 and 2012. Marshalling kiosks and associated control cables are in good condition. There are no condition driven replacements required until 2051.



275kV 1T bay marshalling kiosk



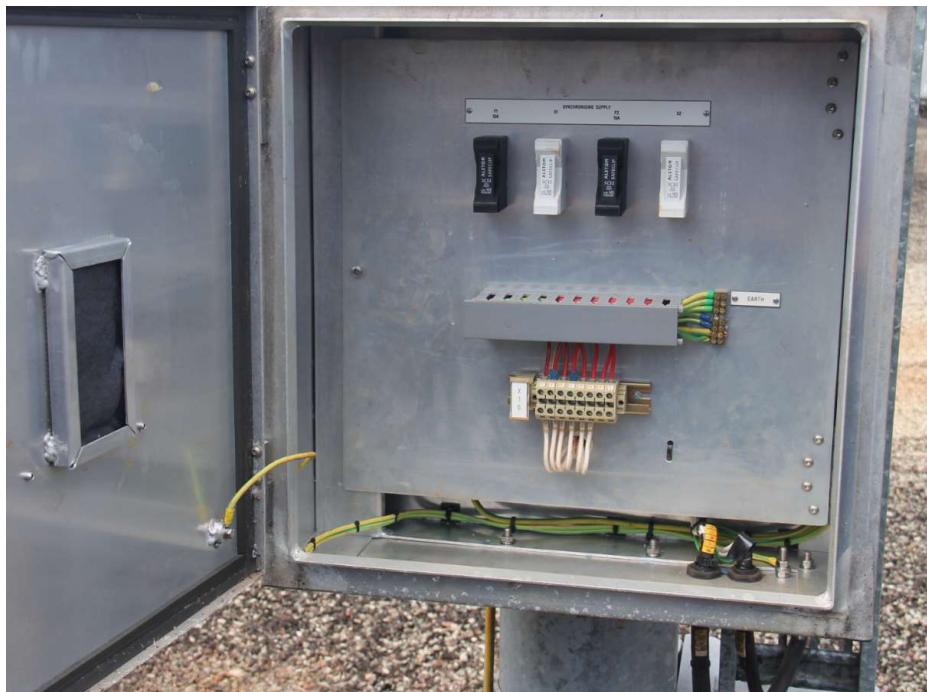
275kV 1T 16VT box

**275kV 2T bay marshalling kiosk****275kV 2T 17VT box**

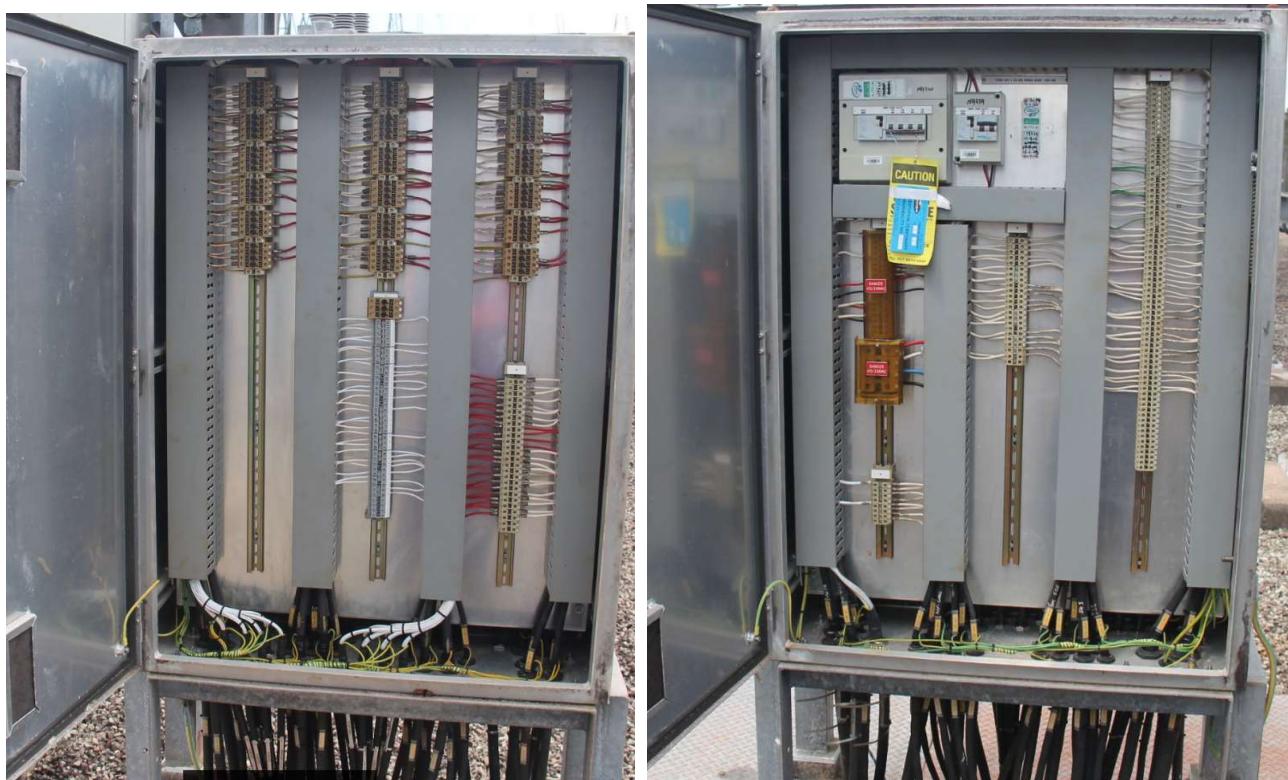
Marshalling kiosks and VT boxes for 275kV feeder 857, 858 and 877 were installed between 2003 and 2004. Marshalling kiosks are in fair condition and there is no condition driven replacement until 2043/2044. VT boxes utilise fuses to protect the circuitry. Fuses do not provide safety and monitoring features and make the event investigation more difficult. Maintenance on these fuses is expensive. These fuses should be replaced with MCBs to improve the performance of circuitries according to current design standard with major secondary system replacement.



275kV Feeder 857 bay marshalling kiosk



275kV Feeder 857 2VT marshalling kiosk



275kV Feeder 858 bay marshalling kiosk



275kV Feeder 858 9VT marshalling kiosk



275kV Feeder 877 bay marshalling kiosk



275kV Feeder 877 13 and 18 VT marshalling kiosk

Marshalling kiosks and VT boxes for 275kV feeder 876 were installed in 2007 and are in good condition. There are no condition-driven required replacement until 2047.



275kV Feeder 876 bay marshalling kiosk



275kV feeder 876 19 and 20 VT marshalling kiosk

Marshalling kiosks for 275kV bus reactor 5 were installed in 2012/2013 and are in good condition. There are no condition-driven required replacement until 2052.

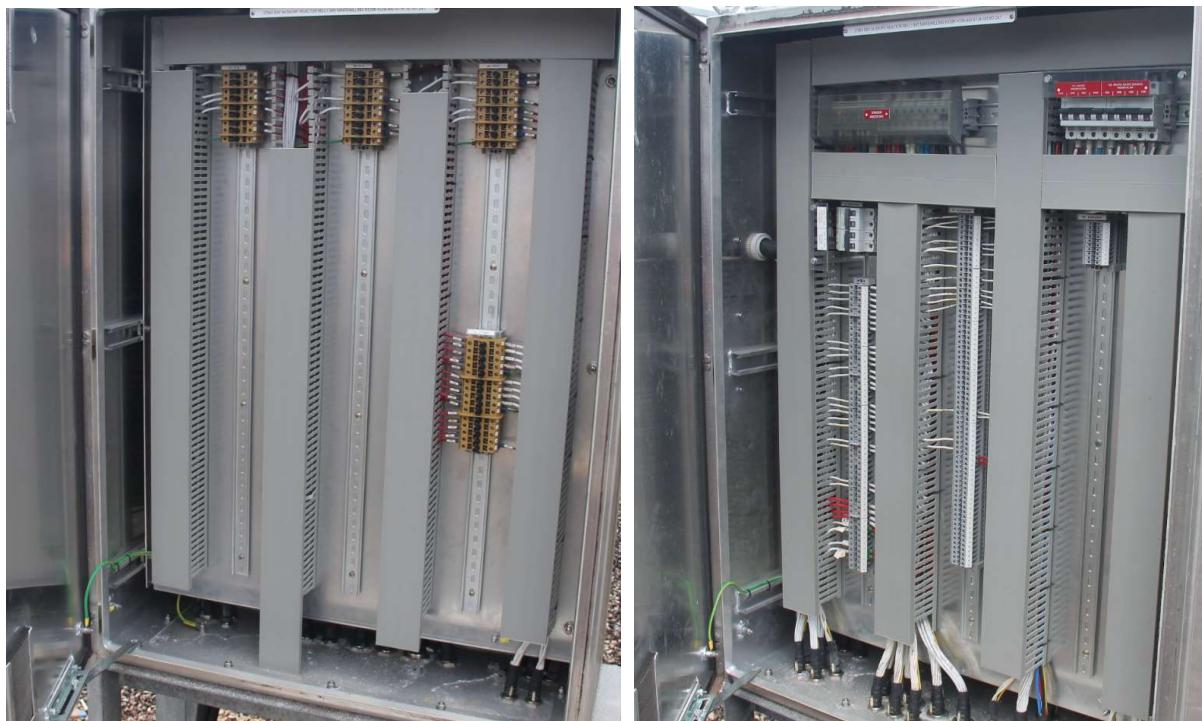


275kV bus reactor 5 bay marshalling kiosk

Marshalling kiosks for 275kV Feeder 857 and 858 reactor were replaced in 2011/2012 and are in good condition. There are no condition-driven required replacement until 2051.



275kV Feeder 857 reactor marshalling kiosk



275kV Feeder 858 reactor marshalling kiosk

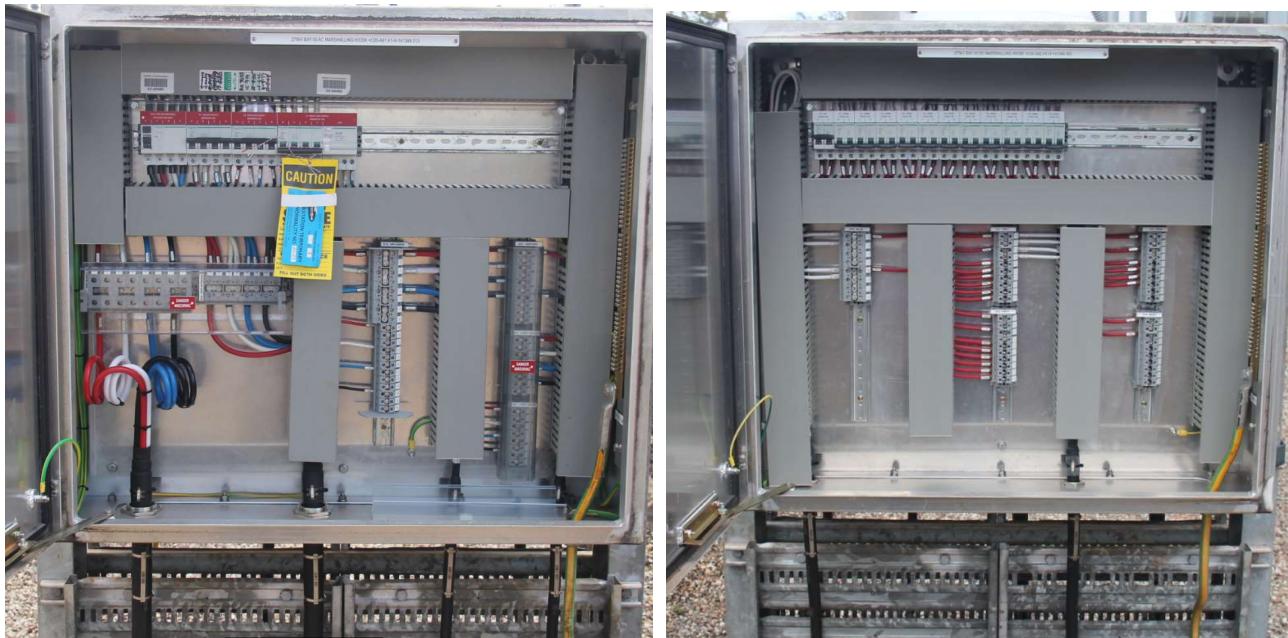
Auxiliary kiosks for 275kV diameter =C03, =C04 and =C05 were commissioned/replaced between 2011/2012. Marshalling kiosks and associated cables are in good condition. There are no condition driven replacement required until 2051.



275kV =C03 AC and DC marshalling kiosk

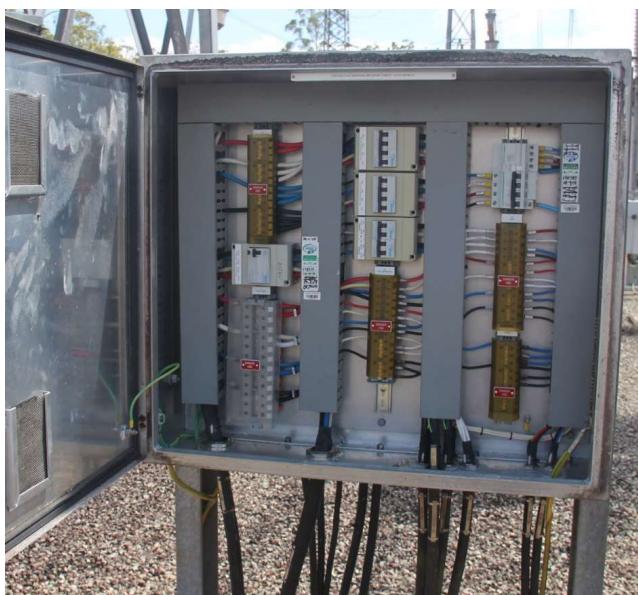


275kV =C04 AC and DC marshalling kiosk



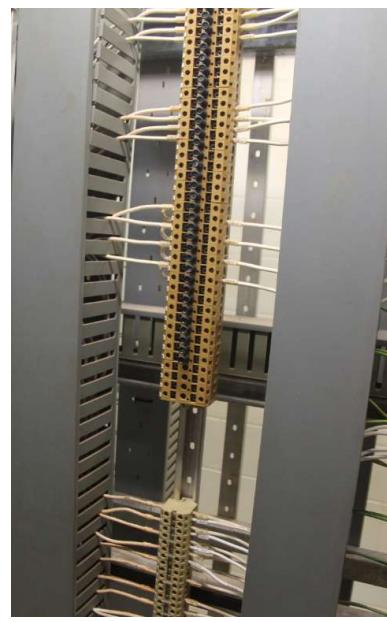
275kV =C05 AC and DC marshalling kiosk

AC marshalling kiosk for 275kV diameter =C06 was commissioned in 2007. Marshalling kiosks and associated cables are in fair condition. There are no condition driven replacement required until 2041. The DC marshalling kiosk for diameter =C06 was installed in 2003. Associated fuses do not provide safety and monitoring features and make the event investigation more difficult. Maintenance on these fuses is expensive. These fuses should be replaced with MCBs to improve the performance of circuitries according to current design standard with major secondary system replacement.



275kV =C06 AC and DC marshalling kiosk

It is a cable termination rack arrangement in Building +1 at H032 Chalumbin. But majority of control cables up to the marshalling kiosks have been wired directly to the protection and control panels and haven't been terminated via the terminal racks. The floor and support structure are intact. Termination racks were built in 1988 and old terminals need to be replaced if these rack are utilised for future secondary system replacement.



Termination racks

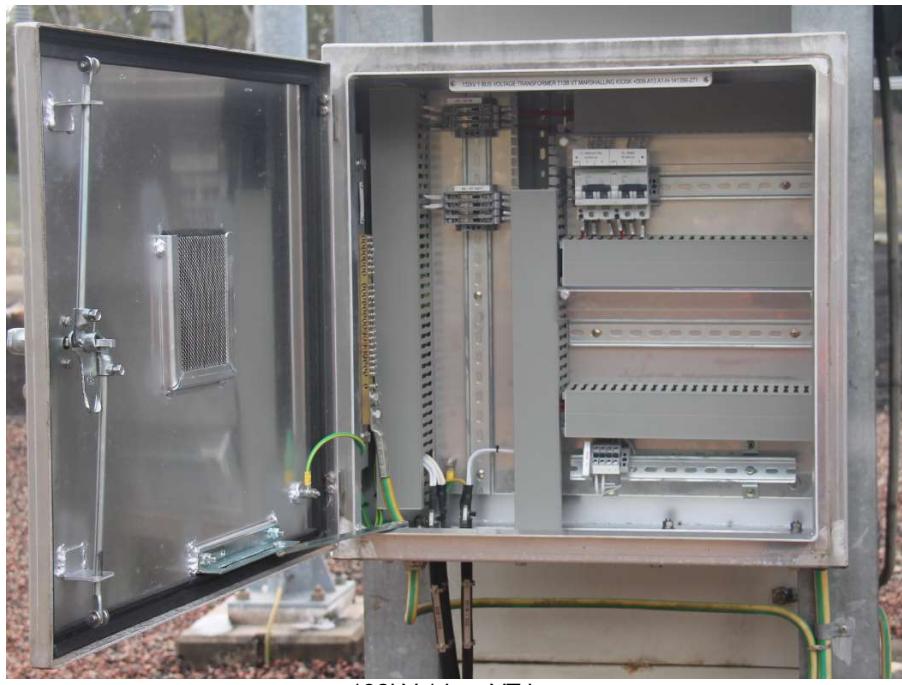
4.2.2 132kV yard

132kV bus and bus coupler marshalling kiosks (including VT boxes) were replaced under CP.01566 Chalumbin secondary system replacement in 2011. These kiosks and associated

control cables are in good condition and there are no condition-driven replacements required until 2051.



132kV 1 Bus CT marshalling kiosk



132kV 1 bus VT box



132kV 2 Bus CT marshalling kiosk



132kV Bay =D03 coupler 411 marshalling kiosk

Marshalling kiosks and VT boxes of 1 and 2 Transformer LV were replaced under CP.01566 Chalumbin secondary system replacement in 2011. These kiosks and associated control cables are in good condition and there are no condition-driven replacements required until 2051.



132kV Bay =D04 1 Transformer LV bay marshalling kiosk



132kV Bay =D04 1 Transformer LV bay 3 VT box



132kV Bay =D06 2 Transformer LV bay marshalling kiosk

Marshalling kiosks and VT boxes for feeder bay =D08, =D07, =D05 and =D06 were replaced under CP.01566 Chalumbin secondary system replacement in 2011. These kiosks and associated control cables are in good condition and there are no condition-driven replacements required until 2051.



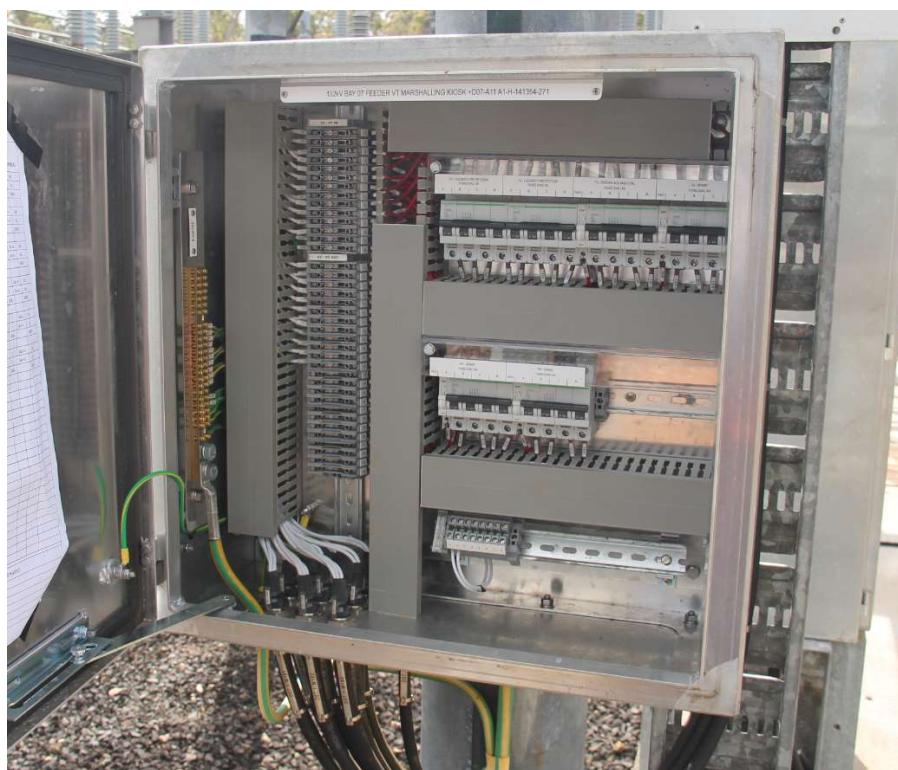
132kV Bay =D08 Feeder 7165 bay marshalling kiosk



132kV Bay =D08 Feeder 7165 8VT box



132kV Bay =D07 Feeder 7166 bay marshalling kiosk



132kV Bay =D07 Feeder 7166 4VT box



132kV Bay =D05 Feeder 7191 bay marshalling kiosk



132kV Bay =D05 Feeder 7191 7VT box



132kV Bay =D06 Feeder 7192 bay marshalling kiosk



132kV Bay =D06 Feeder 7192 6VT box

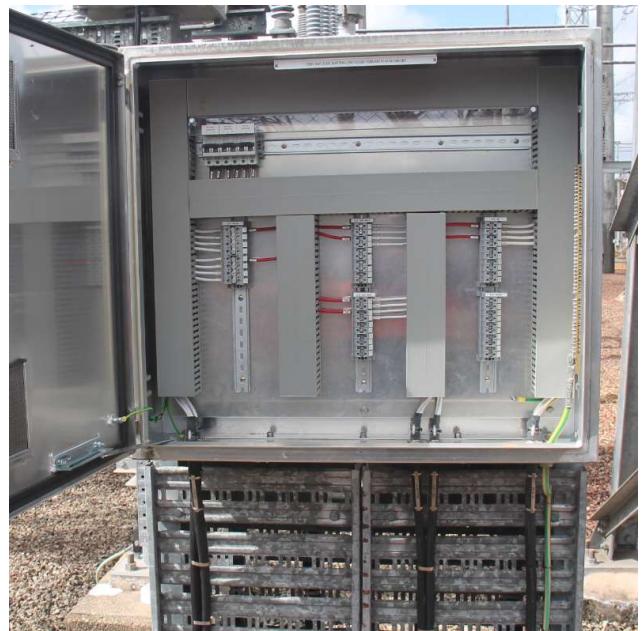
AC/DC marshalling kiosks for 132kV bay =D04, =D06 and =D08 and marshalling kiosks for 1 CAP and 1T shunt reactor were replaced under CP.01566 Chalumbin secondary system replacement in 2011. These kiosks and associated control cables are in good condition and there are no condition-driven replacements required until 2051.



132kV Bay =D04 AC and DC marshalling kiosks



132kV Bay =D06 AC and DC marshalling kiosks



132kV Bay =D08 AC and DC marshalling kiosk



132kV =D09 1 CAP bay marshalling kiosk



132kV 1T shunt reactor marshalling kiosk

Electrical fence was installed at H032 Chalumbin in 2017 and associated control cubicles are in good condition.



Electric fence and associated control cubicle

4.3 Control and protection bays

4.3.1 Protection and control panels

Secondary systems at Chalumbin are housed in a type of swing frame panel. There are safety in design concerns on the type of swing frame panel, such as isolation issues and potential termination falling loose risks. Updates on the panel are required to be conducted with major secondary system replacement according to SU0020 Updates to SDM8 Panels to Mitigate Safety in Design Concerns (Obj ID: A2753457).



4.3.2 275kV Bus zones and couplers

Equipment details of 275kV bus zones and couplers are given below:

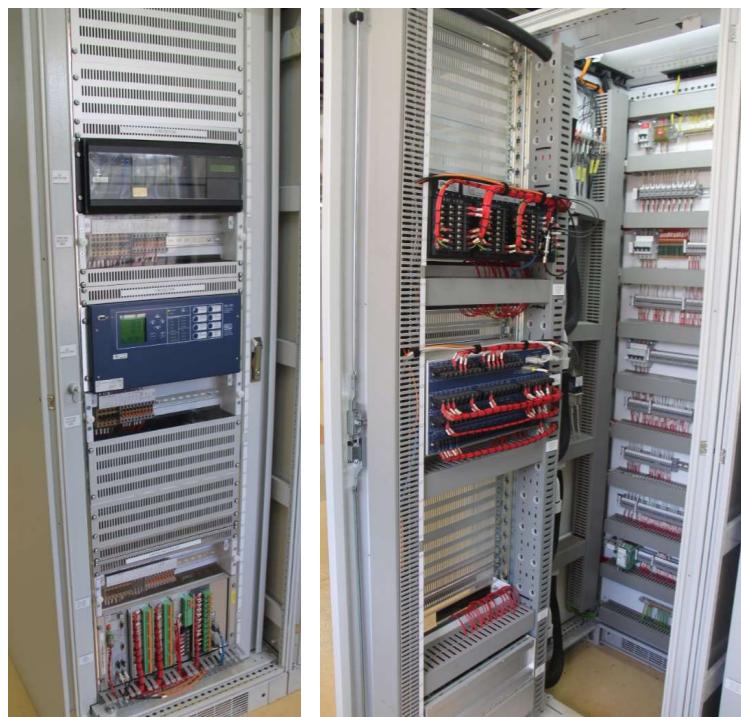
275kV Bus and coupler	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index	
1 Bus	X		2004	Yes	Yes	Yes	7.50	
			2004	Yes	Yes	Yes	7.50	
			2004	Yes	Yes	Yes	7.50	
			2004	Yes	Yes	Yes	7.50	
			2004	Yes	Yes	Yes	7.50	
	Y		2004	Yes	Yes	Yes	7.50	
			2004	Yes	Yes	Yes	7.50	
			2004	Yes	Yes	Yes	7.50	
			2004	Yes	Yes	Yes	7.50	
			2004	Yes	Yes	Yes	7.50	
2 Bus	X		2004	Yes	Yes	Yes	7.50	
			2004	Yes	Yes	Yes	7.50	
			2004	Yes	Yes	Yes	7.50	
			2004	Yes	Yes	Yes	7.50	
			2004	Yes	Yes	Yes	7.50	
	Y		2004	Yes	Yes	Yes	7.50	
			2004	Yes	Yes	Yes	7.50	
			2004	Yes	Yes	Yes	7.50	
			2004	Yes	Yes	Yes	7.50	
			2004	Yes	Yes	Yes	7.50	
Coupler 503	X		2013	No	No	Yes	4.74	
	Y		2013	No	Yes	Yes	3.39	
	RTU		2011	No	Yes	Limited	5.25	
Coupler 504	X		2013	No	No	Yes	4.74	
	Y		2013	No	Yes	Yes	3.39	
	RTU		2013	No	Yes	Limited	6.25	
Coupler 506	X		2004	No	No	Yes	7.5	
	Y		2004	Yes	Yes	Yes	7.5	
	RTU		2004	No	Yes	Limited	7.5	

High impedance differential relays ALSTOM MFAC34 relays are used to protect 275kV 1 and 2 bus. Powerlink has recovered modules of C50 RTU such as the CPU, ACT and ADI card. But these cards have been in service for more than 20 years and the capacitor electrolyte might have been dried out. These recovered parts would be utilised only for emergency replacement. Powerlink has conducted a last buy in 2014 and are relying on these RTUs for maintenance spares. Health Index indicates that all protection and control systems for 275kV 1 and 2 Bus will reach the end of technical asset life and need to be replaced by 2024.

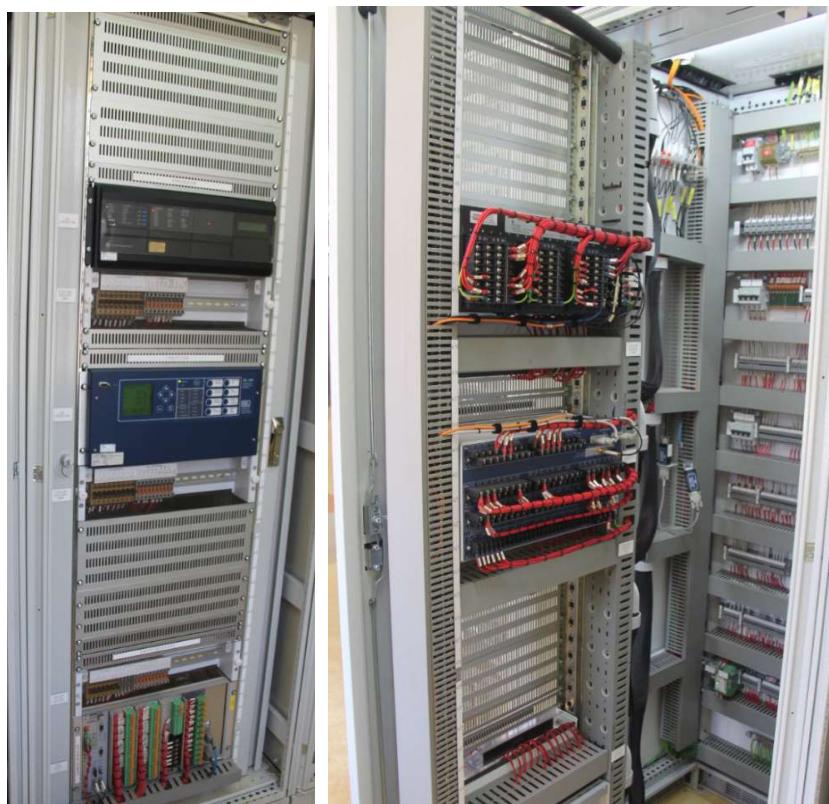


275kV 1 & 2 Bus protection and CB fail bus trip panel

Secondary systems for 275kV coupler 503 and 504 were replaced under CP.01566 Chalumbin secondary system replacement in 2013. These secondary systems are in fair condition and there are no condition driven replacements required until 2033.



Coupler 503 protection/control panel



Coupler 504 protection/control panel

Secondary systems for 275kV coupler 506 were commissioned in 2004. Health Index indicates that all protection and control systems for 275kV Coupler 6 will reach the end of technical asset life and need to be replaced by 2024.



Coupler 506 protection/control panel

4.3.3 275/132kV transformer bays

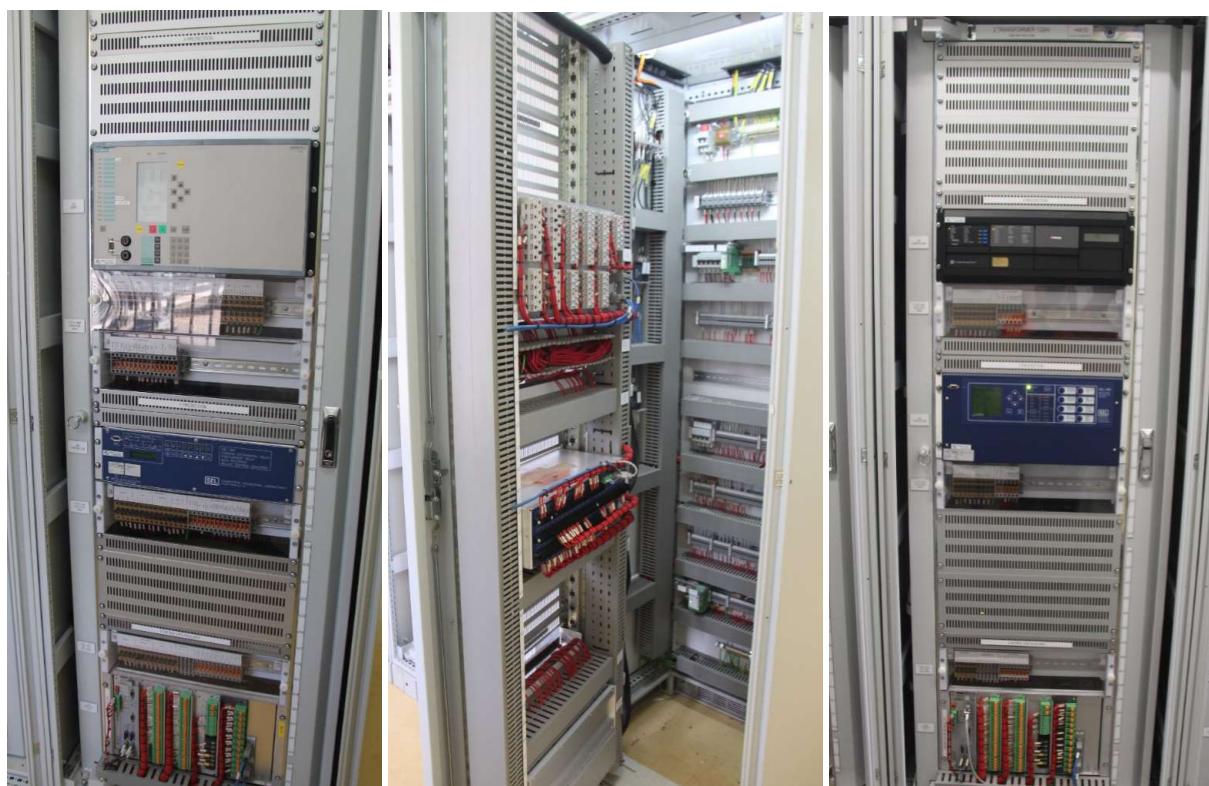
Equipment for 275/132kV transformer bays is detailed below.

Transformer	Relay & control		Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
1T	275kV	X		2013	Yes	Yes	Yes	5.03
		Y		2013	No	Yes	Yes	5.15
		Local RTU		2013	No	Yes	Limited	6.25
	132kV	X CB MGMT		2013	No	No	Yes	4.74
		Y CB MGMT		2013	No	Yes	Yes	3.39
		Local RTU		2013	No	Yes	Limited	6.25
2T	275kV	X		2013	Yes	Yes	Yes	5.03
		Y		2013	No	Yes	Yes	5.15
		Local RTU		2013	No	Yes	Limited	6.25
	132kV	X CB MGMT		2013	No	No	Yes	4.74
		Y CB MGMT		2013	No	Yes	Yes	3.39
		Local RTU		2013	No	Yes	Limited	6.25

Protection and control equipment including the panel for 1& 2 275/132kV transformer were replacement under CP.01566 Chalumbin secondary system replacement in 2013. These secondary systems are in good condition. Health index indicate that there are no condition-driven replacements required until 2033.



1 Transformer 275/132kV protection and control panel



2 Transformer 275/132kV protection and control panel

4.3.4 275kV feeder bays

Protection and control equipment for 275kV feeder bays are detailed in the following table.

Feeder	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
857	X		2006	No	No	Yes	7.77
	2009		No	Yes	Yes	Yes	5.35
	Y		2006	No	No	Yes	6.71
	CVT Monitoring		2006	No	No	Yes	6.71
	Bay control		2006	No	Yes	Limited	6.71
858	X		2005	No	No	Yes	7.02
	2009		No	Yes	Yes	Yes	5.35
	Y		2006	No	No	Yes	6.60
	CVT Monitoring		1999	No	No	Yes	10.00
	Bay control		2005	No	Yes	Limited	7.11
876	X		2018	No	Yes	Yes	0.61
	Y		2009	No	No	Yes	5.27
	Bay control		2007	No	Yes	Limited	6.25
877	X		2012	No	Yes	Yes	5.77
	2004		No	No	Yes	Yes	7.50
	2012		No	Yes	Yes	Yes	5.77
	2012		No	Yes	Yes	Yes	3.71

Feeder	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
Y			2004	No	No	Yes	7.50
	Bay control		2004	No	Yes	Limited	7.50

Majority of protection and control equipment ([REDACTED] for feeders 857 and 858 were commissioned between 2005 and 2006. These devices have become obsolete and manufacturers have ceased the support. Health index shows that they will reach the end of technical asset life and need to be replaced between 2025 and 2026.



Feeder 857 protection and control panel



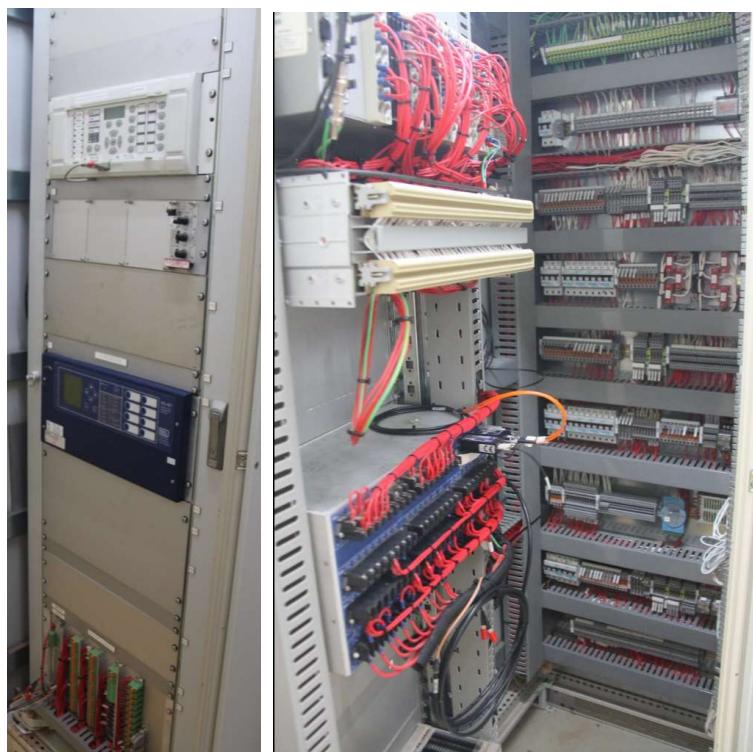
Feeder 858 protection and control panel

Feeder bay 876 was built as part of Woree 275kV reinforcement in 2007. X protection was replaced under CP.02613 Walkamin Sub in 2018. The bay controller RTU and Y protection were installed/refurbished between 2007 and 2009. Associated health index indicates that both Y protection and [REDACTED] RTU will reach the end of technical asset life and need to be replaced between 2027 and 2029.



Feeder 876 bay protection/control panel

Secondary systems for feeder 877 were commissioned in 2004 (except X protection [REDACTED] was replaced under CP.02059 Woree-Chalumbin SPAR in 2012). Health index indicates that these equipment (Communication interface [REDACTED] relay and [REDACTED] RTU) will reach the end of technical asset life and need to be replaced in 2024.



Feeder 877 bay protection/control panel

There is a special arrangement for Woree-Chalumbin feeder 877 on Single Pole Auto-reclose (SPAR) due to the underground cable section. Associated protection [REDACTED] and protection signalling [REDACTED] were installed in 2012 and are in fair condition. But associated protection and comms devices are housed within a tunnel type of construction which has constrained spaces. The panel has exposed terminal in the rear of the panel which could cause safety issues. This type of construction is vulnerable to cause human error on mis-tripping of primary plant when maintenance is conducted and it is also expensive to modify because of the inter panel wiring. These equipment with the panel should be replaced with major secondary system replacement on that bay.



Feeder 877 SPAR scheme panel

4.3.5 275kV Reactors

Secondary systems for 275kV reactors are detailed in a table below.

Reactor	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
Bus reactor	X		2014	Yes	Yes	Yes	2.74
	Y		2014	No	No	Yes	4.74
	POW		2014	No	Yes	Yes	4.80
	Local RTU		2014	Yes	Yes	Yes	6.45
	Local RTU		2014	No	Yes	Limited	6.25
857 Feeder reactor	X		2014	Yes	Yes	Yes	2.70
	Y		2014	No	No	Yes	4.74
	POW		2014	No	Yes	Yes	3.39
	Local RTU		2014	Yes	Yes	Yes	7.54
	Local RTU		2014	No	Yes	Limited	6.25
858 Feeder reactor	X		2014	Yes	Yes	Yes	2.67
	Y		2014	No	No	Yes	4.74
	POW		2014	No	Yes	Yes	3.39
	Local RTU		2014	Yes	Yes	Yes	7.54
	Local RTU		2014	No	Yes	Limited	6.25

High Impedance [REDACTED] and CB management relay [REDACTED] and [REDACTED] are used to protect 275kV bus reactor, Feeder 857 and 858 reactor and mounted on a swing frame panel. These relays have been providing reliable services. There are no condition-driven replacements required until 2034.



275kV Bus reactor protection and control panel



857 feeder reactor protection and control panel



858 feeder reactor protection and control panel



4.3.6 132kV Bus zones and coupler bays

Secondary systems for 132kV bus zones and coupler bays are listed in a table below.

132kV Bus	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index	
1 Bus	X		2013	Yes	Yes	Yes	2.95	
			2013	Yes	Yes	Yes	2.95	
			2012	Yes	Yes	Yes	2.95	
			2012	Yes	Yes	Yes	3.57	
	Y		2012	Yes	Yes	Yes	3.57	
			2012	Yes	Yes	Yes	3.57	
			2012	Yes	Yes	Yes	3.57	
			2012	Yes	Yes	Yes	3.57	
			2012	No	Yes	Limited	6.25	
			2012	Yes	Yes	Yes	3.57	
2 Bus	X		2012	Yes	Yes	Yes	3.57	
			2012	Yes	Yes	Yes	3.57	
			2012	Yes	Yes	Yes	3.57	
			2012	Yes	Yes	Yes	3.57	
	Y		2012	Yes	Yes	Yes	3.57	
			2012	Yes	Yes	Yes	3.57	
			2012	Yes	Yes	Yes	3.57	
			2012	Yes	Yes	Yes	3.57	
			2012	No	Yes	Limited	6.25	
			2012	Yes	Yes	Yes	3.57	
Coupler 411	X		2012	No	No	Yes	6.25	
	Y		2012	No	Yes	Yes	4.74	
	Bay control		2012	No	Yes	Limited	3.57	

Secondary systems for 132kV bus zones and the bus coupler were replaced under CP.01566 Chalumbin secondary system replacement between 2012 and 2013. They are in good condition. There are no condition-driven replacements required until 2032.



132kV 1 Bus zone protection and control panel



132kV 2 Bus zone protection and control panel



132kV Bus coupler protection and control panel

4.3.7 132kV feeder bays

Secondary systems for 132kV feeder bays are detailed in a table below.

Feeder	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
7165	X		2013	No	Yes	Yes	5.77
			2013	No	Yes	Yes	3.60
	Y		2013	Yes	Yes	Yes	5.36
	Bay control		2013	No	Yes	Yes	6.25
7166	X		2013	No	Yes	Yes	5.77
			2013	No	Yes	Yes	3.60
	Y		2013	Yes	Yes	Yes	5.36
	Bay control		2013	No	Yes	Yes	6.25
7191	X		2012	No	Yes	Yes	5.77
			2012	No	Yes	Yes	3.60
	Y		2012	Yes	Yes	Yes	5.36
	Bay control		2012	No	Yes	Yes	3.44
7192	X		2012	No	Yes	Yes	5.77
			2012	No	Yes	Yes	3.60
	Y		2012	Yes	Yes	Yes	5.36
	Bay control		2012	Yes	Yes	Yes	3.42

Feeder	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
	Bay control	[REDACTED]	2012	No	Yes	Yes	6.225

Secondary systems for 132kV Feeder 7165, 7166, 7191 and 7192 were replaced under CP.01566 Chalumbin secondary system replacement between 2012 and 2013. They are in good condition. There are no condition-driven replacements required until 2032-2033.



Feeder 7165 protection and control panel



Feeder 7166 protection and control panel



Feeder 7191 protection and control panel



Feeder 7192 protection and control panel

4.3.8 132kV 1 Capacitor bank

Secondary systems for 132kV 1 capacitor bank are detailed in a table below:

Capacitor	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
1 CAP	X	[REDACTED]	2004	Yes	Yes	Yes	7.53
			2013	Yes	Yes	Yes	3.21
			2013	No	No	Yes	4.74
	Y	[REDACTED]	2013	Yes	Yes	Yes	3.39
	Point On Wave	[REDACTED]	2013	No	Yes	Yes	4.51
	Bay control	[REDACTED]	2013	No	Yes	Yes	6.25

Secondary systems on 132kV 1 Capacitor bank were replaced in 2013. There are no condition-driven replacements required (except SPAJ140C O/C relay) until 2033. The O/C relay, [REDACTED] needs to be replaced in 2024 based on associated health index.



1 CAP protection and control panel

4.3.9 19kV Reactor

Secondary systems for 19kV Reactor are detailed in a table below.

Reactor	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
1 Reactor	19kV	X	2011	No	No	Yes	4.74
			2013	Yes	Yes	Yes	3.15
	Y	[REDACTED]	2013	Yes	Yes	Yes	3.39
	Bay control	[REDACTED]	2013	No	No	Yes	6.25

Secondary systems for 19kV reactor were replaced under CP.01566 Chalumbin secondary system replacement 2013. There are no condition-driven replacements required until 2033.



19kV Reactor protection and control panel

4.3.10 Power System Control and Monitoring

Power system control and monitoring equipment is detailed in a table below:

Power System Control and monitoring	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
Monitoring	Fault locator	[REDACTED]	2010	No	Yes	Yes	5.00

Travelling wave based fault locator was installed in 2010 and is in fair condition. Health index indicates that there is no condition-driven replacement required within 10 years.



Hathaway travelling wave fault locator

4.4 Metering

There are no revenue metering for the electricity market at H032 Chalumbin.



4.5 Non-bays

Secondary systems for Non-bays at H032 Chalumbin are detailed in the following table:

NBay	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
Local control (+1)	HMI Terminal		2012	Yes	Yes	Yes	7.00
	Common RTU		2014	No	Yes	Yes	5.24
Local control (+4)	HMI		2012	No	No	Limited	8.35
	Common RTU		2012	No	Yes	Yes	6.25
Master OpsWAN (+1)	Router		2009	No	Yes	Yes	10.00
	Ethernet Switch		2001	No	No	Yes	10.00
	Serial Port Server		2001	No	No	Yes	10.00
	Serial Port Server		2001	No	No	Yes	10.00
	Terminal Server		2001	No	Yes	Yes	10.00
Station OpsWAN (+4)	Ethernet Switch		2012	Yes	Yes	Yes	6.89
	Ethernet Switch		2012	Yes	Yes	Yes	6.89
	Serial Port Server		2012	Yes	Yes	Yes	6.89
SCADA (+4)	NSC1		2012	No	Yes	Yes	6.25
	NSC2		2012	No	Yes	Yes	6.25
Timing Clock	GPS Clock (+1)		1989	No	Yes	Yes	10.00
	GPA Clock (+4)		2012	Yes	Yes	Yes	5.47

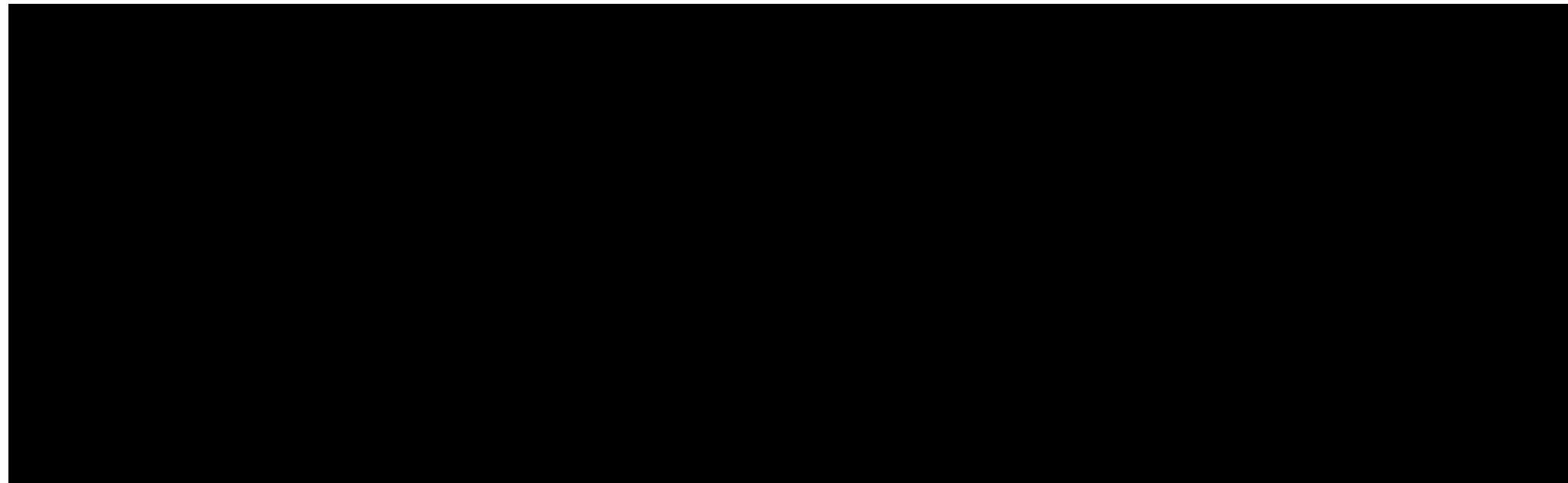
4.5.1 SCADA, Control and OpsWAN

Both 275kV and 132kV OptoNet ring were merged into one under CP.01566 Chalumbin secondary system replacement in 2012.



Secondary System Condition Assessment Report

H032 CHALUMBIN 275/132KV



Objective ID: A3245187

Version No:

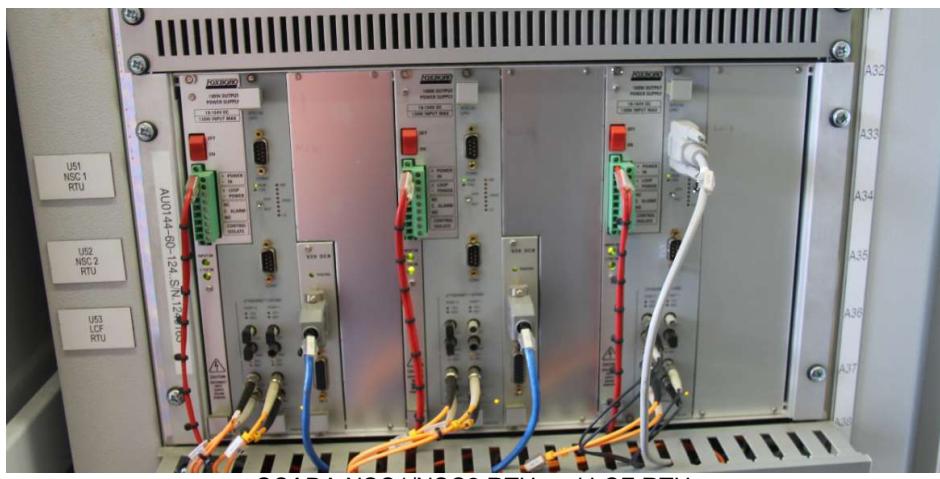
2.0

Issue Date: 09/10/2019

ANY PRINTED VERSION OF THIS DOCUMENT IS UNCONTROLLED

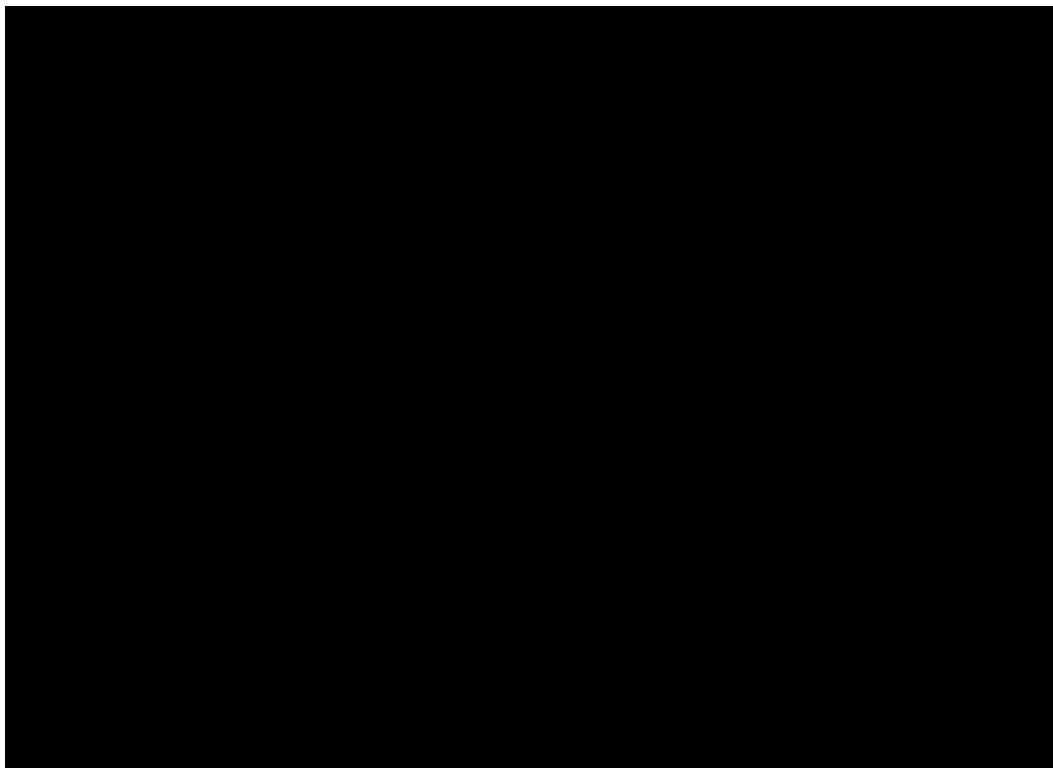
Page 50 of 1

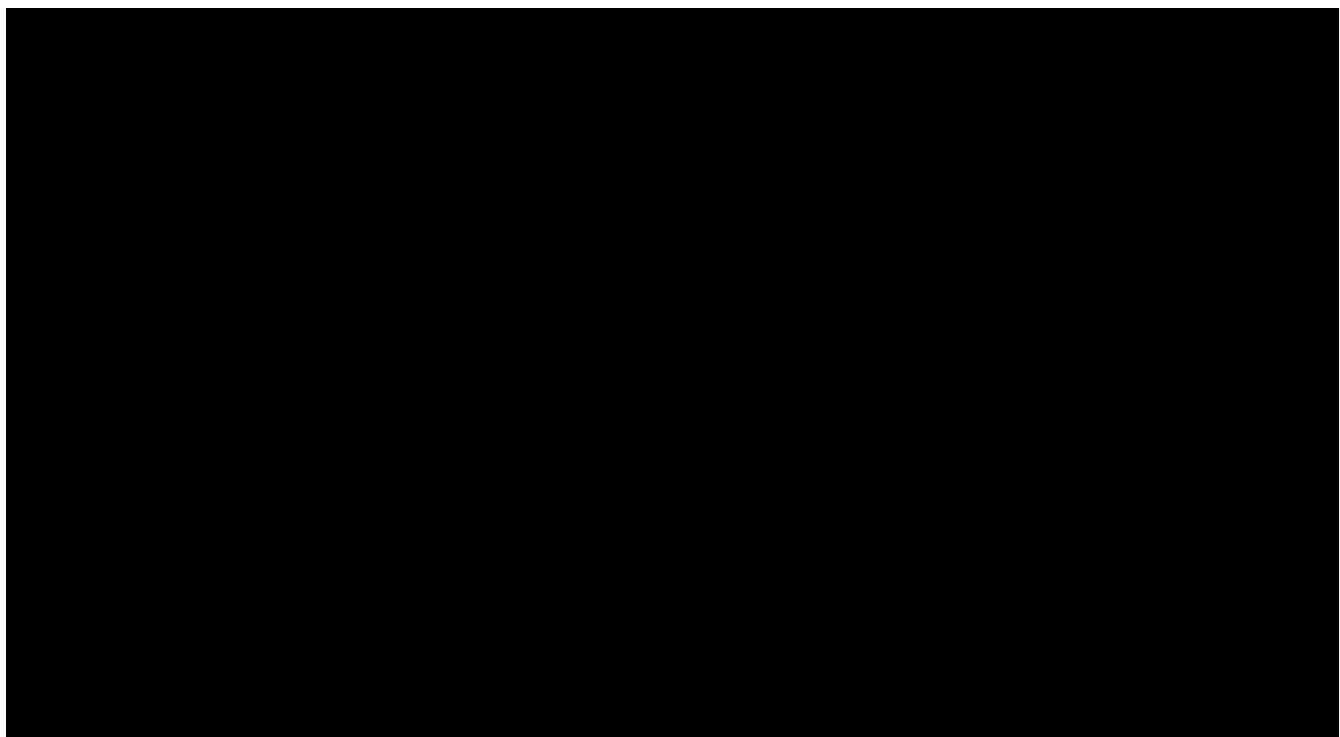
Dedicated SCADA paths have been implemented for 275/132kV secondary systems at H032 Chalumbin. The SCADA system has independent NSC1 and NSC2 RTU to implement 2 x dual SCADA paths based on DNP serial protocol. The serial SCADA is being phased out because of expensive serial infrastructures and will be migrated to DNP over IP under major secondary system replacement.



SCADA NSC1/NSC2 RTU and LCF RTU

Workstation is used for the local control. There are only limited spares available. This equipment needs to be replaced with major secondary system replacement.





Master OpsWAN network in +1 was installed in 2001. Health index indicates that these equipment have reached the end of technical asset life need to be replaced in 2020. Powerlink's strategy is to carry out associate replacement with major secondary system replacement projects.



Master OpsWan panel in Building +1

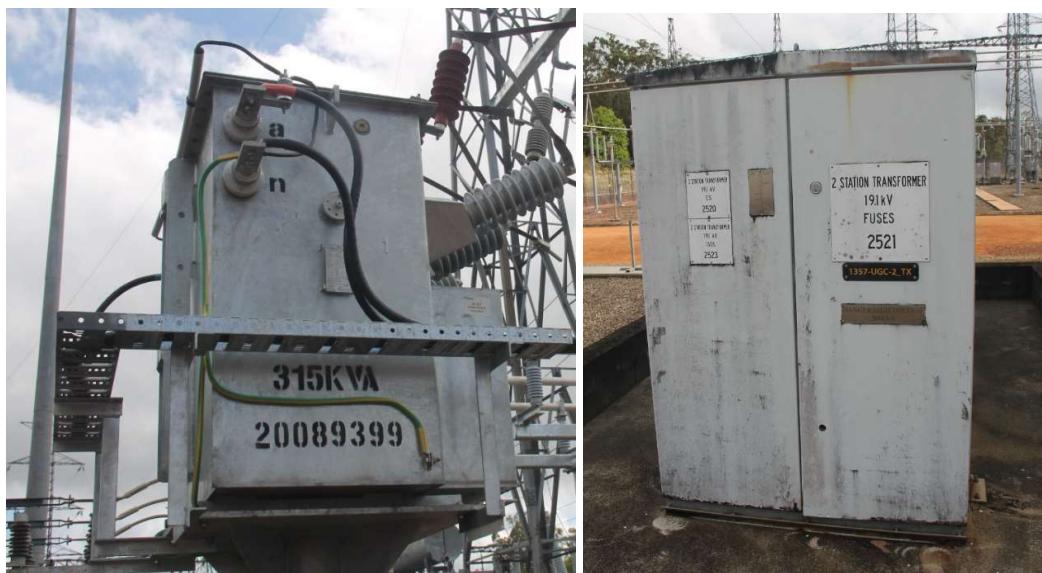
OpsWAN equipment in Building +4 was installed in 2012 and are in fair condition. Health index indicates that these equipment will reach the end of technical asset life and need to be replaced between 2024 and 2025.



Station OpsWAN panel in Building +4

4.5.2 Auxiliary supply

The 415VAC auxiliary supplies are derived from two Powerlink 19.1/433V 315kVA and 200kVA station transformers. Standby AC supply is from an on-site 150kVA diesel generator. Suitable monitoring and changeover arrangement are available for the site. The arrangement is considered acceptable for the situation.



Station transformer 1 and 2

AC change over board was installed in 2009 and is in fair condition.



AC changeover board



On site diesel generator

The AC distribution boards in building +1 were installed in 2012 and are in good condition.



AC distribution board in Building +1

The dual 125VDC and dual 48VDC systems and associated distribution board were replaced in 2014 and 2012 respectively. There are no condition driven replacements required until 2026 and 2024.



125VDC Batteries and charger



48VDC Batteries and charger in building +1

AC distribution boards and associated DC distribution boards in Building +4 were installed in 2012 and are in good condition. There are no condition driven replacements required within 10 years. Dual 125VDC will reach the end of technical asset life and need to be replaced by 2024.



AC distribution boards in building +4



125VDC Batteries and charger in building +4

5. Telecommunication

Communication systems at H032 Chalumbin consist of fibre optic technology with [REDACTED] PDH and [REDACTED] SDH MUX equipment. They have been providing reliable services for protection and control systems. [REDACTED] no longer manufacturers the PDH equipment, and support for hardware replacement is provided by [REDACTED].



SDH and PDH at Building +1



PDH at Building +4

MPLS network has been installed at H032 Chalumbin substation. It can be used by future secondary systems such as SCADA and metering implementation.



MPLS network panel

6. Summary of Asset Health

The asset health of H032 Chalumbin secondary system assets is determined by an assessment of the equipment aging profile, reliability, conditions (including the condition of panel wirings, control cables and marshalling cubicles) and obsolescence. Asset health index of equipment at H032 Chalumbin are summarized in the table below:-



Secondary System Condition Assessment Report

H032 CHALUMBIN 275/132KV

Bay	Functional Loc.	Description	Model number	In Service Date	Health Index	Still Manufactured?	Sec Sys Equipment to be replaced	Protection/control panel HI	Protection/control panel to be replaced	Marshalling kiosks and Control cables HI	Marshalling kiosks and Control cables to be replaced
132kV 1 Bus	H032-SSS-1BU4-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		15/08/2012	6.25	No	2032	1.75	2052	1.97	2051
	H032-SSS-1BU4-XPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12		13/11/2013	2.95	Yes					
	H032-SSS-1BU4-XPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13		13/11/2013	2.95	Yes					
	H032-SSS-1BU4-XPROT	RELAY CB FAIL BUS TRIP RACK		15/08/2012	3.57	Yes					
	H032-SSS-1BU4-XPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC		13/11/2013	2.95	Yes					
	H032-SSS-1BU4-YPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12		15/08/2012	3.57	Yes					
	H032-SSS-1BU4-YPROT	RELAY CB FAIL BUS TRIP RACK		15/08/2012	3.57	Yes					
	H032-SSS-1BU4-YPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13		15/08/2012	3.57	Yes					
	H032-SSS-1BU4-YPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC		15/08/2012	3.57	Yes					
275kV 1 Bus	H032-SSS-1BU5-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		04/10/2004	7.50	No	2024	3.75	2044	3.92	2043-2044
	H032-SSS-1BU5-XPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC		04/10/2004	7.50	Yes					
	H032-SSS-1BU5-XPROT	RELAY CB FAIL BUS TRIP RACK		04/10/2004	7.50	Yes					
	H032-SSS-1BU5-XPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13		04/10/2004	7.50	Yes					
	H032-SSS-1BU5-XPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12		04/10/2004	7.50	Yes					
	H032-SSS-1BU5-YPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC		04/10/2004	7.50	Yes					
	H032-SSS-1BU5-YPROT	RELAY CB FAIL BUS TRIP RACK		04/10/2004	7.50	Yes					
	H032-SSS-1BU5-YPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13		04/10/2004	7.50	Yes					
	H032-SSS-1BU5-YPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12		04/10/2004	7.50	Yes					
19kV 1 Reactor Bay	H032-SSS-271--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		19/06/2013	6.25	No	2033	1.50	2053	1.97	2051
	H032-SSS-271--XPROT	RELAY CB MGMT GE C60 (5.22) 100BASE FX		28/12/2011	4.74	No					
	H032-SSS-271--XPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC		19/06/2013	3.15	Yes					
	H032-SSS-271--YPROT	RELAY CB MGMT SEL-451 1A, 125VDC		19/06/2013	3.39	No					
132kV 2 Bus	H032-SSS-2BU4-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		15/08/2012	6.25	No	2032	1.75	2052	1.97	2051
	H032-SSS-2BU4-XPROT	RELAY CB FAIL BUS TRIP RACK		15/08/2012	3.57	Yes					
	H032-SSS-2BU4-XPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC		15/08/2012	3.57	Yes					
	H032-SSS-2BU4-XPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13		15/08/2012	3.57	Yes					
	H032-SSS-2BU4-XPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12		15/08/2012	3.57	Yes					
	H032-SSS-2BU4-YPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12		15/08/2012	3.57	Yes					
	H032-SSS-2BU4-YPROT	RELAY CB FAIL BUS TRIP RACK		15/08/2012	3.57	Yes					
	H032-SSS-2BU4-YPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13		15/08/2012	3.57	Yes					
	H032-SSS-2BU4-YPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC		15/08/2012	3.57	Yes					
275kV 2 Bus	H032-SSS-2BU5-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		04/10/2004	7.50	No	2024	3.75	2044	3.92	2043-2044
	H032-SSS-2BU5-XPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC		04/10/2004	7.50	Yes					
	H032-SSS-2BU5-XPROT	RELAY CB FAIL BUS TRIP RACK		04/10/2004	7.50	Yes					
	H032-SSS-2BU5-XPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13		04/10/2004	7.50	Yes					
	H032-SSS-2BU5-XPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12		04/10/2004	7.50	Yes					
	H032-SSS-2BU5-YPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC		04/10/2004	7.50	Yes					
	H032-SSS-2BU5-YPROT	RELAY CB FAIL BUS TRIP RACK		04/10/2004	7.50	Yes					
	H032-SSS-2BU5-YPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13		04/10/2004	7.50	Yes					
	H032-SSS-2BU5-YPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12		04/10/2004	7.50	Yes					



Secondary System Condition Assessment Report

H032 CHALUMBIN 275/132KV

2T	H032-SSS-2TRF-CONTSYS	OLTC / COOLER / ALARM PLC		11/11/2015	1.95	Yes	2035	1.00	2055	\	\
132kV 1-2 bus coupler	H032-SSS-411--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		15/08/2012	6.25	No	2032	1.75	2052	1.97	2051
	H032-SSS-411--XPROT	RELAY CB MGMT GE C60 (5.22) 100BASE FX		15/08/2012	4.74	No					
	H032-SSS-411--YPROT	RELAY CB MGMT SEL-451 1A, 125VDC		15/08/2012	3.57	No					
	H032-SSS-441--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		19/06/2013	6.25	No		2033	1.50	2053	1.97
132kV 1T	H032-SSS-441--XPROT	RELAY CB MGMT GE C60 (5.22) 100BASE FX		19/06/2013	4.74	No					
	H032-SSS-441--YPROT	RELAY CB MGMT SEL-451 1A, 125VDC		19/06/2013	3.39	No					
	H032-SSS-442--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		13/08/2013	6.25	No	2033	1.50	2053	1.97	2051
132kV 2T	H032-SSS-442--XPROT	RELAY CB MGMT GE C60 (5.22) 100BASE FX		13/08/2013	4.74	No					
	H032-SSS-442--YPROT	RELAY CB MGMT SEL-451 1A, 125VDC		13/08/2013	3.39	No					
	H032-SSS-481--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		13/11/2013	6.25	No	2024	1.50	2044	1.97	2051
132kV 1 CAP	H032-SSS-481--POWAVE	RELAY POINT ON WAVE ABB E213		13/11/2013	4.51	No					
	H032-SSS-481--XPROT	STABILISED INST O/C RELAY		14/09/2004	7.53	Yes					
	H032-SSS-481--XPROT	RELAY CB MGMT GE C60 (5.22) 100BASE FX		13/11/2013	4.74	No					
	H032-SSS-481--XPROT	RELAY CAP PROTN ABB SPAJ160C		13/11/2013	3.21	Yes					
	H032-SSS-481--YPROT	RELAY CB MGMT SEL-451 1A, 125VDC		13/11/2013	3.39	No					
	H032-SSS-503--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		08/08/2011	6.25	No	2033	1.50	2053	1.96	2051
275kV 503 Coupler	H032-SSS-503--XPROT	RELAY CB MGMT GE C60 (5.22) 100BASE FX		19/06/2013	4.74	No					
	H032-SSS-503--YPROT	RELAY CB MGMT SEL-451 1A, 125VDC		19/06/2013	3.39	No					
	H032-SSS-504--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		13/08/2013	6.25	No	2033	1.50	2053	1.96	2051
275kV 504 Coupler	H032-SSS-504--XPROT	RELAY CB MGMT GE C60 (5.22) 100BASE FX		13/08/2013	4.74	No					
	H032-SSS-504--YPROT	RELAY CB MGMT SEL-451 1A, 125VDC		13/08/2013	3.39	No					
	H032-SSS-506--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		04/10/2004	7.50	No	2024	3.75	2044	3.98	2043
275kV 506 Coupler	H032-SSS-506--XPROT	RELAY CBM AN GE C60 (WITH W6T MODULE)		04/10/2004	7.50	No					
	H032-SSS-506--YPROT	RELAY CBM AN SEL-352 (1A) (3U)		04/10/2004	7.50	Yes					
275kV 1T	H032-SSS-541--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		19/06/2013	6.25	No	2033	1.50	2053	1.97	2051
	H032-SSS-541--XPROT	RELAY TX BIAS DIFF SIEMENS 7UT635		19/06/2013	5.03	Yes					
	H032-SSS-541--YPROT	RELAY BIASED DIFF SEL-387-5 (1A) (3U)		19/06/2013	5.15	No					
275kV 2T	H032-SSS-542--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		13/08/2013	6.25	No	2033	1.50	2053	1.97	2051
	H032-SSS-542--XPROT	RELAY TX BIAS DIFF SIEMENS 7UT635		13/08/2013	5.03	Yes					
	H032-SSS-542--YPROT	RELAY BIASED DIFF SEL-387-5 (1A) (3U)		13/08/2013	5.15	No					
275kV 1 Bus Reactor	H032-SSS-575--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		10/04/2014	6.25	No	2034	1.25	2054	1.71	2052
	H032-SSS-575--POWAVE	RELAY POW SS CONTROLLER MITSUBISHI DTCB		10/04/2014	6.45	Yes					
	H032-SSS-575--XPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC		10/04/2014	2.74	Yes					
	H032-SSS-575--XPROT	RELAY CB MGMT GE C60 (5.22) 100BASE FX		10/04/2014	4.74	No					
	H032-SSS-575--YPROT	RELAY CB MGMT SEL-451-5 1A, 125VDC		10/04/2014	4.80	No					
132kV Feeder 7165	H032-SSS-7165--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		23/04/2013	6.25	No	2033	1.50	2053	1.97	2051
	H032-SSS-7165--XPROT	RELAY CURR DIFF DISTANCE MICOM P546		23/04/2013	5.77	No					
	H032-SSS-7165--XPROT	COMMS INTERFACE UNIT ALSTOM P591		23/04/2013	3.60	No					
	H032-SSS-7165--YPROT	RELAY DISTANCE SCHW'ZER 421-5 1A 24 LED		23/04/2013	5.36	Yes					
132kV Feeder 7166	H032-SSS-7166--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		15/04/2013	6.25	No	2033	1.50	2053	1.97	2051
	H032-SSS-7166--XPROT	RELAY CURR DIFF DISTANCE MICOM P546		15/04/2013	5.77	No					



Secondary System Condition Assessment Report

H032 CHALUMBIN 275/132KV

	H032-SSS-7166-XPROT	COMMS INTERFACE UNIT ALSTOM P591		15/04/2013	3.60	No							
	H032-SSS-7166-YPROT	RELAY DISTANCE SCHW'ZER 421-5 1A 24 LED		15/04/2013	5.36	Yes							
132kV Feeder 7191	H032-SSS-7191-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		14/11/2012	6.25	No							
	H032-SSS-7191-PSLEO	MODULE REMOTE I/O SEL-2506 (15KM RANGE)		14/11/2012	3.44	Yes							
	H032-SSS-7191-XPROT	RELAY CURR DIFF DISTANCE MICOM P546		14/11/2012	5.77	No							
	H032-SSS-7191-XPROT	COMMS INTERFACE UNIT ALSTOM P591		14/11/2012	3.60	No							
	H032-SSS-7191-YPROT	RELAY DISTANCE SCHW'ZER 421-5 1A 24 LED		14/11/2012	5.36	Yes							
	H032-SSS-7192-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		30/11/2012	6.25	No							
132kV Feeder 7192	H032-SSS-7192-PSLEO	MODULE REMOTE I/O SEL-2506 (15KM RANGE)		30/11/2012	3.42	Yes							
	H032-SSS-7192-XPROT	RELAY CURR DIFF DISTANCE MICOM P546		30/11/2012	5.77	No							
	H032-SSS-7192-XPROT	COMMS INTERFACE UNIT ALSTOM P591		30/11/2012	3.60	No							
	H032-SSS-7192-YPROT	RELAY DISTANCE SCHW'ZER 421-5 1A 24 LED		30/11/2012	5.36	Yes							
	H032-SSS-857-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		08/05/2006	6.71	No							
275kV/kV Feeder 857	H032-SSS-857-SUPERV	CVT MONITOR		08/05/2006	6.71	No							
	H032-SSS-857-XPROT	CURR DIFF RELAY ALSTOM P544 + 2ND PORT		08/05/2006	7.77	No							
	H032-SSS-857-XPROT	COMMS INTERFACE UNIT ALSTOM P591		23/01/2009	5.35	No							
	H032-SSS-857-YPROT	RELAY DISTANCE SEL-421 (1A) (5U)		08/05/2006	6.71	No							
	H032-SSS-857-YPROT	RELAY DISTANCE SEL-421 (1A) (5U)		08/11/2007	5.96	No							
	H032-SSS-857-BAYCONTR	REMOTE TERMINAL UNIT FOXBORO C50		09/05/2014	6.25	No							
Feeder 857 Reactor	H032-SSS-857-POWAVE	POINT ON WAVE RELAY F236 ABB		09/05/2014	7.54	No							
	H032-SSS-857-XPROTR	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC		09/05/2014	2.70	Yes							
	H032-SSS-857-XPROTR	RELAY CB MGMT GE C60 (5.22) 100BASE FX		09/05/2014	4.74	No							
	H032-SSS-857-YPROTR	RELAY CB MGMT SEL-451 1A, 125VDC		09/05/2014	3.39	No							
	H032-SSS-858-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		17/07/2005	7.11	No							
275kV/kV Feeder 858	H032-SSS-858-SUPERV	F858 CVT MONITOR		30/06/1980	10.00	No							
	H032-SSS-858-XPROT	CURR DIFF RELAY ALSTOM P544 + 2ND PORT		23/09/2005	7.02	No							
	H032-SSS-858-XPROT	COMMS INTERFACE UNIT ALSTOM P591		23/01/2009	5.35	No							
	H032-SSS-858-YPROT	RELAY DISTANCE SEL-421 (1A) (5U)		28/07/2006	6.60	No							
	H032-SSS-858-BAYCONTR	REMOTE TERMINAL UNIT FOXBORO C50		30/05/2014	6.25	No							
Feeder 858 Reactor	H032-SSS-858-POWAVE	POINT ON WAVE RELAY F236 ABB		30/05/2014	7.54	No							
	H032-SSS-858-XPROTR	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC		30/05/2014	2.67	Yes							
	H032-SSS-858-XPROTR	RELAY CB MGMT GE C60 (5.22) 100BASE FX		30/05/2014	4.74	No							
	H032-SSS-858-YPROTR	RELAY CB MGMT SEL-451 1A, 125VDC		30/05/2014	3.39	No							
	H032-SSS-876-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		31/07/2007	6.25	No							
275kV/kV Feeder 876	H032-SSS-876-X2ARBLK	COMMS INTERFACE UNIT ALSTOM P591		07/02/2012	3.83	No							
	H032-SSS-876-XPROT	CURR DIFF RELAY MICOM P544 + 2ND PORT		03/04/2012	5.16	No							
	H032-SSS-876-XPROT	RELAY CURR DIFF DISTANCE MICOM P546		23/07/2018	0.61	No							
	H032-SSS-876-YPROT	RELAY DISTANCE SEL-421 (1A) (5U)		29/03/2009	5.27	No							
	H032-SSS-877-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50		04/10/2004	7.50	No							
275kV/kV Feeder 877	H032-SSS-877-POWAVE	CAT CONTROLLER ABB POW BREAKERS		19/07/2012	3.61	Yes							
	H032-SSS-877-X2ARBLK	RELAY CURR DIFF DISTANCE MICOM P546		01/05/2012	5.77	No							
	H032-SSS-877-X2ARBLK	COMMS INTERFACE UNIT ALSTOM P591		01/05/2012	3.71	No							



Secondary System Condition Assessment Report

H032 CHALUMBIN 275/132KV

Non Bay	H032-SSS-877-XPROT	COMMS INTERFACE UNIT ALSTOM MITZ01	[REDACTED]	04/10/2004	7.50	No	To be replaced with major secondary system replacement	\	\	\	\
	H032-SSS-877-XPROT	RELAY TRIP MONITORING RMS 3A20K26		04/10/2004	7.50	No					
	H032-SSS-877-XPROT	RELAY Curr DIFF DISTANCE MICOM P546		26/05/2012	5.77	No					
	H032-SSS-877-YPROT	RELAY DISTANCE SEL-421 (1A)		04/10/2004	7.50	No					
	H032-SSS-NBAY-DATCONV	REMOTE TERMINAL UNIT FOXBORO C50		06/09/2002	8.54	No					
	H032-SSS-NBAY-LCF	LOCAL CONTROL FACILITY SUN BLADE (REV.7)		30/11/2012	8.35	No					
	H032-SSS-NBAY-LCFINT4	REMOTE TERMINAL UNIT FOXBORO C50		15/08/2012	6.25	No					
	H032-SSS-NBAY-NSCLNK14	REMOTE TERMINAL UNIT FOXBORO C50		15/08/2012	6.25	No					
	H032-SSS-NBAY-NSCLNK24	REMOTE TERMINAL UNIT FOXBORO C50		15/08/2012	6.25	No					
	H032-SSS-NBAY-OWCAM1	VIDEO CAMERA		12/06/2001	10.00	Yes					
	H032-SSS-NBAY-OWCAM2	VIDEO CAMERA		12/06/2001	10.00	Yes					
	H032-SSS-NBAY-OWNTWK	PORT SERVER		12/06/2001	10.00	No					
	H032-SSS-NBAY-OWNTWK	PORT SERVER		12/06/2001	10.00	No					
	H032-SSS-NBAY-OWNTWK	SWITCH		08/06/2001	10.00	No					
	H032-SSS-NBAY-OWNTWK	ROUTER CISCO 2811 48VDC - OPSWAN		20/05/2009	10.00	No					
	H032-SSS-NBAY-OWNTWK4	SWITCH E/NET 32PRT RUGGED RSG2300 OPSWAN		14/11/2012	6.89	Yes		\	\	\	\
	H032-SSS-NBAY-OWNTWK4	SWITCH E/NET 18PRT RUGGED RSG2100 OPSWAN		14/11/2012	6.89	Yes					
	H032-SSS-NBAY-OWNTWK4	SWITCH E/NET 18PRT RUGGED RSG2100 OPSWAN		14/11/2012	6.89	Yes					
	H032-SSS-NBAY-OWNTWK4	SERVER PORT 48VDC PERLE 04030450 -OPSWAN		14/11/2012	6.89	Yes					
	H032-SSS-NBAY-OWNTWK4	SERVER PORT 48VDC PERLE 04030450 -OPSWAN		14/11/2012	6.89	Yes					
	H032-SSS-NBAY-OWPRINT	PRINTER		23/04/2001	10.00	Yes					
	H032-SSS-NBAY-OWSERV	SERVER		06/06/2001	10.00	No					
	H032-SSS-NBAY-OWSERV	MONITOR		06/06/2001	10.00	Yes					
	H032-SSS-NBAY-RTUCOM2	REMOTE TERMINAL UNIT FOXBORO C50		06/03/2014	6.25	No					
	H032-SSS-NBAY-RTUCOM4	REMOTE TERMINAL UNIT FOXBORO C50		15/08/2012	6.25	No					
	H032-SSS-NBAY-RTUINVRT	INVERTER 125VDC/240VAC 1600W		09/06/2006	10.00	Yes					
	H032-SSS-NBAY-TIMING	GPS CLOCK - ARBITER 1088B		01/07/1989	10.00	No					
	H032-SSS-NBAY-TIMING4	GPS CLOCK TEKRON TCG01-D:1		14/11/2012	5.47	Yes					
	H032-SSS-NBAY-TWFL	FAULT LOCATOR HATHAWAY TWS 4 CIRCUIT		11/06/2010	5.00	No					



7. Conclusion

Based on the condition assessment, the main recommendations for the replacement of secondary systems equipment at H032 Chalumbin are:-

1. Conduct following secondary system replacements by 2024:-

- Replace all fuses with MCBs for =C06 AC/DC marshalling kiosks
- Replace 275kV 1 and 2 Bus protection and control equipment and update the protection and control panel according to SU0020
- Replace 275kV coupler 506 protection and control equipment and update the protection and control panel according to SU0020
- Replace 275kV Feeder 877 protection and control equipment and update the protection and control panel according to SU0020 (including the special SPAR scheme)
- Upgrade the SDACA DNP serial to NP/IP
- Replace [REDACTED] workstation
- Replace OpsWAN in Building +1 and Building +4
- Replace 125VDC battery and associated chargers in Building +1
- Replace 125VDC battery and associated chargers in Building +4
- Replace Arbiter GPS clock in building +1

2. Conduct following secondary system replacements by 2026:-

- Replace all fuses with MCBs for Feeder 857 and 858 VT boxes
- Replace protection and control equipment for Feeder 857 and update the protection and control panel according to SU0020
- Replace protection and control equipment for Feeder 858 and update the protection and control panel according to SU0020
- Replace protection and control equipment for Feeder 876 and update the protection and control panel according to SU0020
- Replace dual 48VDC battery and associated chargers in Building +1

3. Carry out following secondary system replacements by 2033:-

- Replace all secondary systems for 275kV coupler 503 and 504
- Replace all secondary systems for 275/132kV 1T and 2T
- Replace all secondary systems for 275kV bus reactor
- Replace all secondary systems for 275kV Feeder 857 reactor
- Replace all secondary systems for 275kV Feeder 858 reactor
- Replace all secondary systems for 132kV 1 and 2 Bus
- Replace all secondary systems for 132kV bus coupler
- Replace all secondary systems for 132kV feeder 7165
- Replace all secondary systems for 132kV feeder 7166
- Replace all secondary systems for 132kV feeder 7191
- Replace all secondary systems for 132kV feeder 7192
- Replace all secondary systems for 132kV 1 Cap
- Replace all secondary systems for 1T 19kV Reactor
- Replace SCADA RTU C50 and common RTUs C50 in building +1 and +4
- Replace the TWS fault locator
- Replace Tekron GPS clock in building +4



8. References

- (1) National Electricity Rules (NER) Version 106, AEMC, 27/02/2018
- (2) AM-POL-0463 Protection Design, Powerlink, 25/02/2014
- (3) AM-POL-0970 Secondary Systems Design, Powerlink, 05/05/2009
- (4) OSD - SCADA Requirements for Operational Purposes - Standard, Powerlink, 13/01/2016
- (5) AM-POL-0169 Secondary Systems Maintenance Policy, Powerlink, 3/11/2008
- (6) AM-POL-0053 AC and DC Supplies, Powerlink, 08/05/2014
- (7) [SU0023 Clearance Requirements for Panels, Switchboard and Kiosks](#), ID&TS, 06/05/2016
- (8) SU0020 Updates to SDM8 Panels to Mitigate Safety in Design Concerns (Obj. ID: A2753457), 09/2017

Planning Report		27/10/2020
Title	CP.02498 Chalumbin 275kV Substation Reinvestment	
Zone	Far North Queensland (FNQ)	
Need Driver	Emerging risks arising from the condition, safety and obsolescence of Chalumbin 275kV substation aging primary and secondary systems	
Network Limitation	Chalumbin Substation is required to meet Powerlink Queensland's N-1-50MW/600MWh Transmission Authority reliability standards and maintain power transfer capability to Far North Queensland.	
Pre-requisites	None	

Executive Summary

Ageing and obsolete secondary systems at Chalumbin Substation are increasingly at risk of failing to comply with Schedule 5.1.9(c) of the National Electricity Rules and AEMO's Power System Security Guidelines¹.

Powerlink's Central scenario forecast confirms an enduring need for ongoing supply of bulk electricity to the Cairns and Atherton Tableland areas. In order to achieve this there is an enduring need to maintain the 275kV connection between Ross and FNQ (via Chalumbin Substation) and provide a 132kV connection to the Turkinje Substation.

The recommended solution is to replace selected 275kV primary plant, secondary systems and Built Section 1356 cables and associated sealing ends at Chalumbin substation.

This project will be executed in conjunction with CP.03144 Chalumbin 132kV Substation Reinvestment project as the most effective solution to meeting Powerlink's jurisdictional and Rules obligations. This will ensure ongoing compliance with Powerlink's Electricity Act, Electrical Safety Act and Electricity Safety Regulation obligations.

¹ AEMO, Power System Operating Procedure SO_OP_3715, Power System Security Guidelines, V95, September 2019 (the Rules require AEMO to develop and publish Power System Operating Procedures pursuant to clause 4.10.1(b) of the Rules, which Powerlink must comply with per clause 4.10.2(b)).

Table of Contents

Executive Summary	1
1. Introduction	3
2. Scope of Works	4
3. Far North Queensland (FNQ) Demand Forecast	5
4. Statement of Investment Need	7
5. Network Risk	7
6. Non-Network Options	11
7. Network Options.....	11
7.1 Preferred Option to address the identified need	11
7.2 Options considered but not proposed	12
7.2.1 Do Nothing.....	12
8. Recommendations.....	12
9. References.....	12
10. Appendix A – Market Impact Assessment	13

1. Introduction

Chalumbin Substation, located on the Atherton Tableland, in the Koombooloomba National Park, was originally established in 1988. It serves as a major switching station with feeds into both Woree and Turkinje substations. The Chalumbin Substations also connects the Kareeya Power Station at 132kV.

Figures 1 and 2 show the geographic location and network topology within the area of the Chalumbin Substation.



Figure 1. Far North zone transmission network

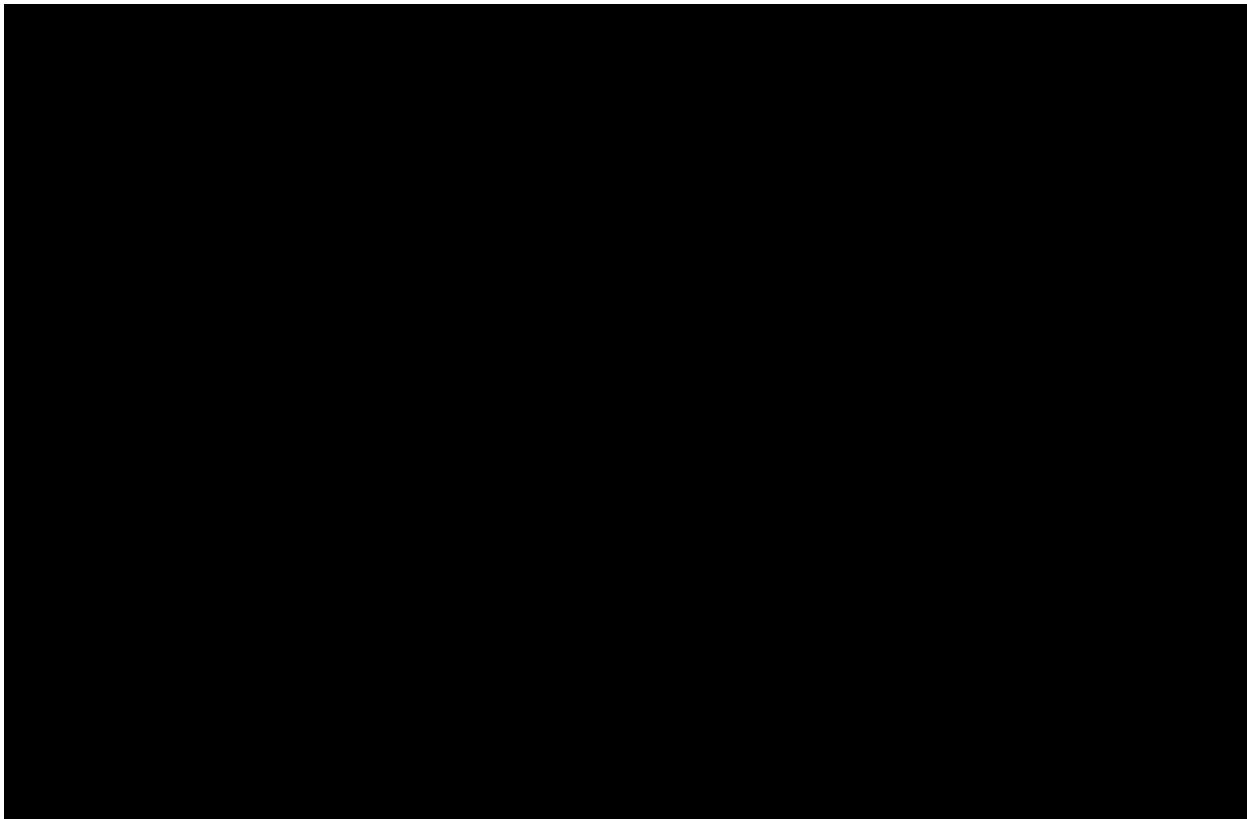


Figure 2. Single Line Diagram of FNQ Region

2. Scope of Works

The majority of the Primary equipment is now approaching 40 years of life. The condition assessment [1] has identified issues related to selected primary plant.

The substation has undergone feeder and bay extensions and modifications since its original construction, that has resulted in the staged installation of secondary systems from 2004 to 2014. A Secondary Systems condition assessment [2] has identified that the 132kV secondary systems installed in demountable building +4 in 2012 is due for replacement. In addition, selected 275kV secondary systems also require replacement (refer to Figure 3).

In addition to the site-specific impacts of obsolescence at Chalumbin Substation's 275kV systems, it is also important to note that running multiple secondary systems to failure across the network increases the likelihood of concurrent systemic faults with significant implications for network reliability and safety.

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

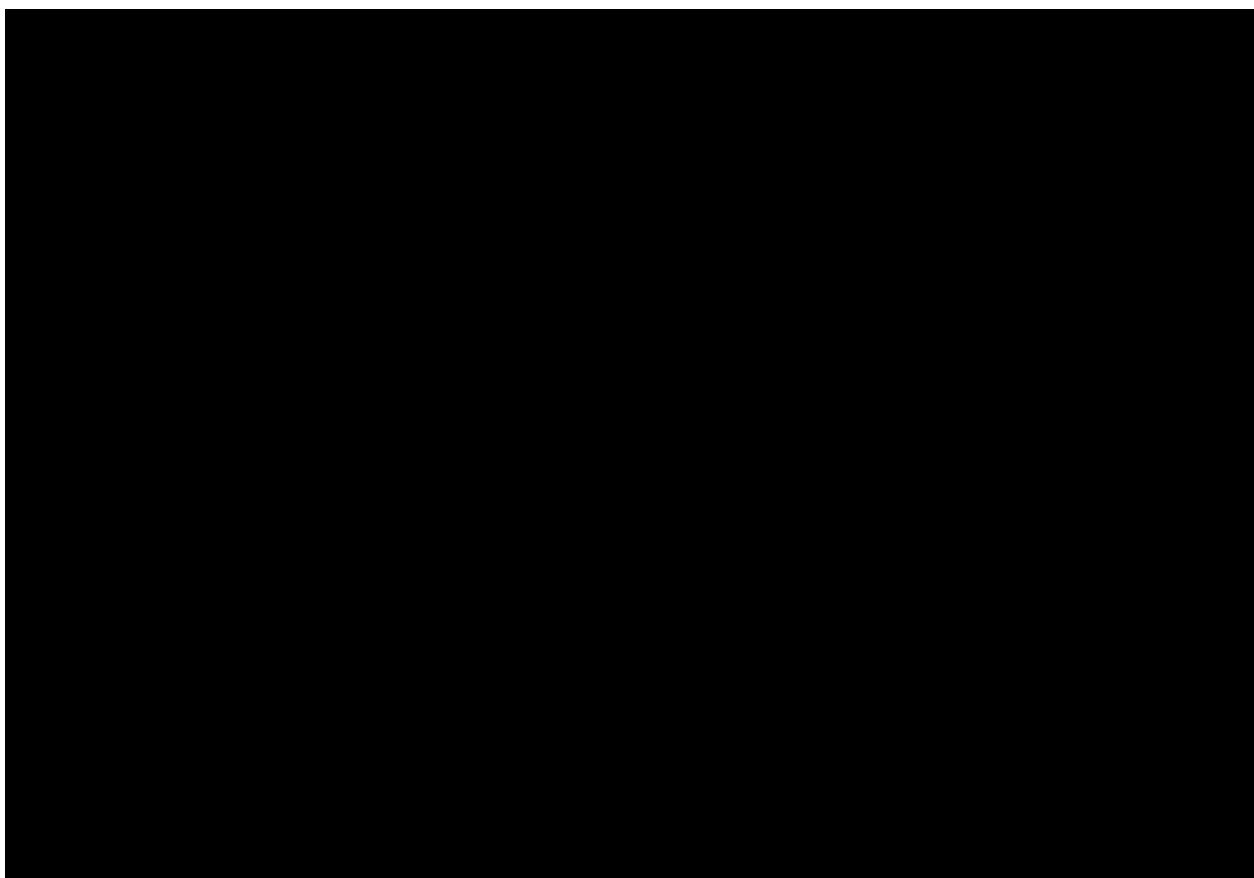
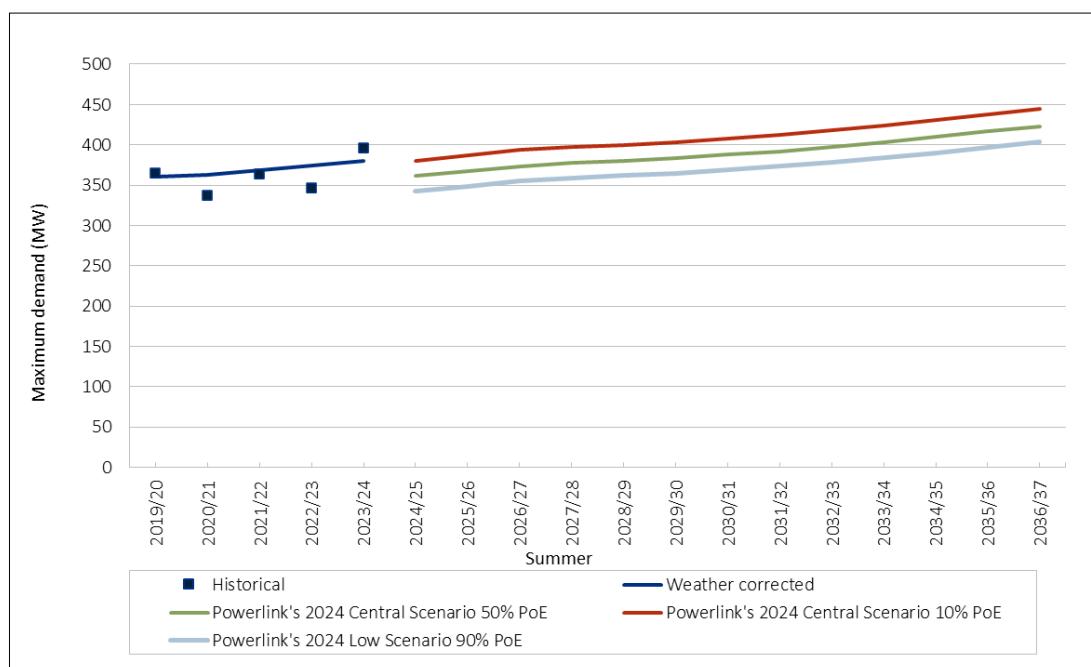


Figure 3. Chalumbin 275kV Line Diagram

3. Far North Queensland (FNQ) Demand Forecast

The FNQ region, as described in Figure 2, includes the load from North of Tully South to Woree. Figure 4 shows that the maximum demand for these loads is expected to increase over the coming years.



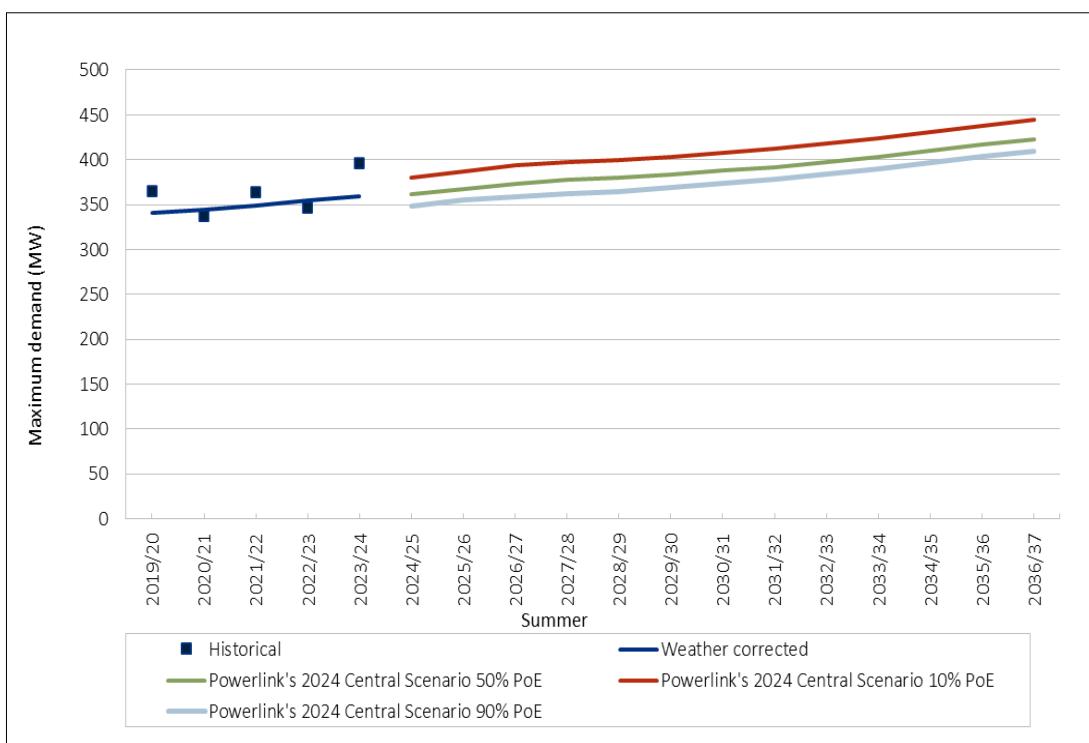


Figure 4. Far North Queensland maximum demand forecasted

The Historical load duration curves for the FNQ area are shown in Figure 5.

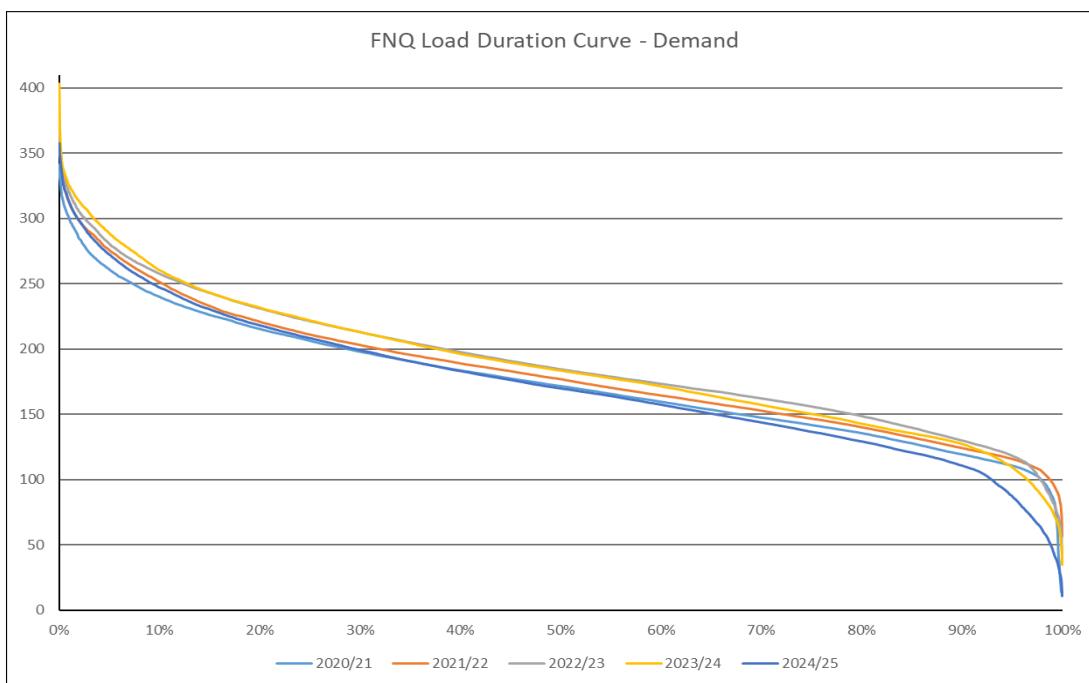


Figure 5. Historical Load Duration Curves for FNQ

With consideration of rooftop PV, the Ergon Energy loads supplied from the FNQ network, is significantly higher than the delivered demand. Figure 6 shows that rooftop PV meets nearly 150MW of underlying demand.

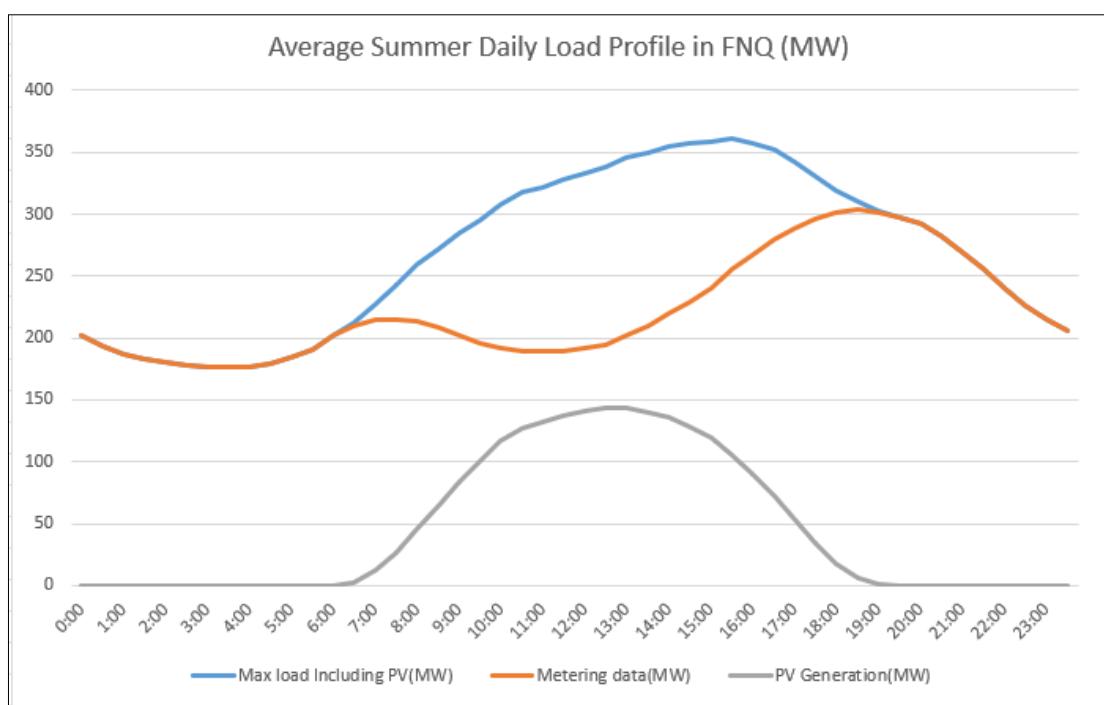


Figure 6. Average Summer Daily Load Profile for FNQ

4. Statement of Investment Need

The Chalumbin Substation serves as a major switching station with feeds into both Woree and Turkinje substations. The Chalumbin Substations also connects the Kareeya Power Station at 132kV.

Removing the functionality of this substation would result in the loss of local supply to Turkinje Substation (and Lakeland Solar Farm) and Kareeya Power Station and significantly impact the performance of the FNQ grid section and the reliability of supply to loads in Far North Queensland.

Additionally, outage of 275kV circuits between Ross and Chalumbin substation (feeders 858 and 857) will result in a market impact of Mt Emerald and Kaban wind farms and put FNQ load at risk for the next credible contingency (outage of the remaining 275kV line between Ross and Woree substation – 8905).

Therefore, secondary system replacement and part primary plant replacement at Chalumbin Substation are required to avoid system failures that would result in loss of load in excess of Powerlink's N-1-50MW / 600MWh Transmission Authority reliability standard. There would also be significant impact to the system strength and power transfer capability of the generators in FNQ.

5. Network Risk

If the aging assets of the secondary system of the 275/132kV transformer at Chalumbin are decommissioned and no further investments are made, a next credible contingency following this would result load loss at Turkinje, which is directly connected to Chalumbin Substation. This situation breaches the N-1-50MW and 600MWh planning criteria. Besides this, outage of 275/132kV transformer at Chalumbin will place Kareeya PS at risk.

Table 1 below presents the load at risk for the load connected via 275/132kV transformers at Chalumbin.

Table 1 – Chalumbin 132kV Load at Risk

At Risk	Contingency	Metric	2023/24		2033/34	
			Metered load	Native load (incl PV)	Delivered load	Native load (incl PV)
Turkinje Craiglie Lakeland	Outage of Chalumbin 275/132kV transformers (1) (2)	Max (MW)	86	119	94	156
		Average (MW)	46	57	45	70
		24h Energy Unserved Max (MWh)	1465	1833	1691	2267
		24h Energy Unserved Average (MWh)	1091	1369	1069	1681

Note

- (1) Two secondary system failures would need to occur to remove 1T or 2T from service
Therefore, N-3 would need to occur to result in loss of load
- (2) There are primary elements associated with 1T that would remove 1T from service for the 1st event. Therefore, N-2 can result in loss of load

Loss of 275/132kV transformation at Chalumbin Substation will also remove the connection of the Kareeya Power Station. This will have both a market and system strength impact.

The market impact has been quantified by determining the maximum and average difference in total system costs (including emission reduction benefits) per 24-hour period with and without the at-risk circuits in-service. The analysis also takes account of any impact on the operation the VRE plant due to system strength impacts.

The analysis assumes that there is no impact on the generation investment pathway as a result of this outage.

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

The market impact is summarised in Table 2.

Table 2. Market impact of Kareeya Power Station out-of-service

At Risk	Contingency	Metric	\$M
Kareeya Power Station	Outage of 1T and 2T at H032 Chalumbin (primary or secondary systems) (1) (2)	Max 24h incremental system cost (\$m)	0.511
		Average 24h incremental system cost (\$m)	0.056

Note

- (1) Two secondary system failures would need to occur to remove 1T or 2T from service
Therefore, N-3 would need to occur to result in loss of Kareeya Power Station

- (2) There are primary elements associated with 1T that would remove 1T from service for the 1st event. Therefore, N-2 can result in loss of Kareeya Power Station

Table 3 summarises the load at risk for primary and/or secondary system failure that disconnects the Chalumbin to Guybal Munjan substations. For this outage the coastal 132kV network is radialised², placing load and generation at risk for an outage of the remaining 275kV circuit into Woree.

Table 3. Far North Queensland Load at Risk

At Risk	Contingency	Metric	2024 (Metered data)	2024 (Max load incl PV)
Far North Queensland Load (Turkinje, Edmonton, Cairns, Kamerunga)	Outage of Chalumbin to Guybal Munjan 275kV feeders) (1) And outage of Ross to Woree (8905)	Max (MW)	403	490
		Average (MW)	178	229
		24h Energy Unserved Max (MWh)	6883	8028
		24h Energy Unserved Average (MWh)	4259	5503
Edmonton	Failure of BS1220 (F857 and F858) OR BS1671 (F8916 and F8917) (Ross to Chalumbin 275kV feeders) And trip of Woree to Edmonton (7284)	Max (MW)	48	101
		Average (MW)	19	34
		24h Energy Unserved Max (MWh)	706	1,259
		24h Energy Unserved Average (MWh)	459	803

Note

- (1) Outages of impacted primary plant (e.g. CVTs) can take a circuit out-of-service. Therefore, the loss of the load in the Table 3 is for an N-3 event.

An outage of the two circuits between Chalumbin and Guybal Munja will have a system strength impact. The System Strength constraint will constraint Mt Emerald Wind Farm to 0MW and Kaban Wind Farm to 80% (based on the current constraint in place for outages of 858 and 857).

Table 4 – System Strength impact of an outage between Chalumbin and Guybal Munjan substations

² The 132kV coastal circuit is split following an outage of the inland 275kV double circuit lines between Ross, Guybal Munjan, Chalumbin and Woree substations between Edmonton and Innisfail substations.

At Risk	Contingency	Metric	\$M
Constraint on Mt Emerald WF and Kaban WF	Outage of Chalumbin to Guybal Munjan circuits	Max 24h incremental system cost (\$m)	0.716
		Average 24h incremental system cost (\$m)	0.135

Note

- (1) Outages of impacted primary plant (e.g. CVTs) can take a circuit out-of-service. Therefore, the market impact in Table 4 is for a N-2 event.

If there is a subsequent outage of 8905 then all generation in FNQ will be lost. This is an N-3 event and hence is ignored.

Table 5 summarises the load at risk for primary and/or secondary system failure that disconnects Chalumbin to Walkamin and Tumoulin substations. For this outage the coastal 132kV network is radialised, placing load and generation at risk for an outage of the remaining 275kV circuit into Woree.

Table 5. Far North Queensland Load at Risk

At Risk	Contingency	Metric	2024 (Metered data)	2024 (Max load incl PV)
Far North Queensland Load (Turkinje, Edmonton, Cairns, Kamerunga)	Outage of Chalumbin to Walkamin and Tumoulin 275kV feeders (1) And outage of Ross to Woree (8905)	Max (MW)	403	490
		Average (MW)	178	229
		24h Energy Unserved Max (MWh)	6883	8028
		24h Energy Unserved Average (MWh)	4259	5503
Edmonton	Outage of Chalumbin to Walkamin and Tumoulin 275kV feeders (1) And trip of Woree to Edmonton (7284)	Max (MW)	48	101
		Average (MW)	19	34
		24h Energy Unserved Max (MWh)	706	1,259
		24h Energy Unserved Average (MWh)	459	803

Note

- (1) Outages of impacted primary plant (e.g. CVTs) can take a circuit out-of-service. Therefore, the loss of the load in the Table 5 is for an N-3 event.

An outage of the two circuits between Chalumbin and Walkamin and Tumoulin substations will also have an impact on system strength. For this outage combination the current system strength advice is to constraint Mt Emerald Wind Farm to 0MW and Kaban Wind Farm to 80% (based on the current constraint in place for outages of 876 and 8932).

Table 6. System Strength impact of an outage between Chalumbin and Walkamin and Tumoulin substations

At Risk	Contingency	Metric	\$M
Constraint on Mt Emerald WF and Kaban WF	Outage of Chalumbin to Walkamin and Tumoulin circuits (1)	Max 24h incremental system cost (\$m)	0.716
		Average 24h incremental system cost (\$m)	0.135

Note

- (1) Outages of impacted primary plant (e.g. CVTs) can take a circuit out-of-service. Therefore, the market impact in Table 6 is for a N-2 event.

Note: Lakeland PV (non-scheduled) will not be able to generate for these combinations of outages (including the Chalumbin transformers). The associated market impact has not been included in the market impact analysis above.

6. Non-Network Options

Non-network solutions would need to replicate, in part or full, the support that Chalumbin Substation delivers to customers in the area on a cost-effective basis.

The potential non-network solutions would need to provide support to Turkinje loads. To meet the demands of Turkinje loads, non-network solution must be capable of delivering up to 150MW and 2250MWh and provide reliable supply to Turkinje Substation and frequency and reference voltage to Lakeland PV.

In addition, the Kareeya Power Station is directly connected to Chalumbin Substation and provides system strength and fault current support for the renewable generations. The non-network solution would need to provide equivalent system strength and protection grade fault current.

The non-network solution would be required to be capable of operating continuous basis.

Powerlink is not aware of any Demand Side Solutions (DSM) in the FNQ area capable of meeting this requirement. However, Powerlink welcomes submissions from proponents who consider that they could offer a non-network solution in full or in part on an ongoing basis and will investigate the feasibility of any potential non-network option proposed or otherwise identified.

7. Network Options

This section discusses the options which were considered to address the above identified condition based secondary systems issues.

7.1 Preferred Option to address the identified need

The recommended solution is to replace the at-risk primary plant and secondary system systems at Chalumbin Substation.

It is planned to replace selected 275kV primary plant and secondary systems and Built Section 1356 cables and associated sealing ends at Chalumbin substation.

This project will be executed in conjunction with CP.03144 Chalumbin 132kV Substation Reinvestment project as the most effective solution to meeting Powerlink's jurisdictional and Rules obligations. This will ensure ongoing compliance with Powerlink's Electricity Act, Electrical Safety Act and Electricity Safety Regulation obligations.

7.2 Options considered but not proposed

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

7.2.1 Do Nothing

"Do Nothing" would not be an acceptable option as the primary drivers (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. Recommendations

There is an investment need to replace the selected 275kV Chalumbin Secondary Systems and primary plant for Powerlink to continue to meet its reliability of supply obligations.

The recommended option is to replace selected 275kV primary plant, secondary systems and Built Section 1356 cables and associated sealing ends at Chalumbin substation.

This project will be executed in conjunction with CP.03144 Chalumbin 132kV Substation Reinvestment project as the most effective solution to meeting Powerlink's jurisdictional and Rules obligations. This will ensure ongoing compliance with Powerlink's Electricity Act, Electrical Safety Act and Electricity Safety Regulation obligations.

9. References

1. H032 Chalumbin Electrical Condition Assessment Report Rev 2 (obj A5638035)
2. PIF Primary Plant Replacement H32 Chalumbin Substation (obj A2886203)
3. CP.02948 Chalumbin 275kV Substation Reinvestment - Project Scope (obj A5146460)
4. 2025 Transmission Annual Planning Report (A6049612)
5. Asset Planning Criteria - Framework (ASM-FRA-A2352970)
6. Powerlink Queensland's Transmission Authority T01/98

10. Appendix A – Market Impact Assessment

Market modelling was used to assess the operational market impact from failure of primary and secondary systems at the Chalumbin 275kV Substation. The outages impact the availability and capacity of the wind farms and hydro power stations in Far North Queensland.

The market modelling approach is consistent with the regulatory investment test for transmission requirements that a market benefit “must be a benefit to those who consume, produce and/or transport electricity in the market, that is, the change in producer plus consumer surplus.” Critically, a market benefit must not “include the transfer of surplus between consumers and producers”.³

As such, the market impact is assessed by comparing the changes in costs for market participants due to the differences in the operational and maintenance costs (including fuel costs), changes in involuntary load shedding (at the value of customer reliability [VCR]⁴), and changes in greenhouse gas emissions (at the value of emissions reduction [VER]⁵)

The market modelling simulations considered committed and anticipated generators were commissioned on time, coal units closed according to their announced dates (as of December 2025), and modelled generation and storage projects consistent with the Queensland Energy Roadmap 2025.⁶ The profiles of demand and energy available for variable energy resources followed the 2015 weather reference year as published by AEMO, as being a year found to result in ‘median’ outcomes.

A schedule of generator planned outages was modelled. However, generator forced outages were not considered. Instead, a reserve requirement is maintained via a reserve constraint equation, and therefore unserved energy may be underestimated in some circumstances.

Appropriate network detail (in the form of network constraints or sub-regional transfer limits) was added to adequately represent the network capability across major grid sections.

The outage (and corresponding impact on Far North Queensland generation) was modelled as occurring in perpetuity to approximately capture the effect of this occurring at any time.

The market impact was then quantified as the differential total system cost (as above) for each hour between a base case with the full generation capacity available against the state of the world with an outage or constraint on this generation. Both the hourly and a moving 24-hour differential cost were determined.

The values in the report tables capture the maximum differential total system cost for any 24-hour period (averaged over the 5-year analysis period) and the average differential total system cost for a 24-hour period (over the 5-year analysis period).

³ AER, November 2024, “Regulatory investment test for transmission”, p4

⁴ AER, December 2024, “Values of customer reliability: Final report on VCR values” available at

⁵ AER, May 2024, “Valuing emissions reduction: AER guidance and explanatory statement”

⁶ The State of Queensland (Queensland Treasury), October 2025, “Energy Roadmap”



Project Scope Report

Network Portfolio

Project Scope Report

CP.02948

H032 Chalumbin 275kV Substation Reinvestment

Proposal – Version 3

Document Control

Change Record

Issue Date	Revision	Prepared by	Reviewed by	Approved by	Background
6/3/25	1				
24/6/25	2				Added installation of surge arrestors on F8932 Added replacement of additional F858 SAs (highlighted in Attachment 1)
2/10/25	3				Updated to request Class 3 estimate for preferred option

Related Documents

Issue Date	Responsible Person	Objective Document Name
3/9/24		PIF Primary Plant Replacement H32 Chalumbin Substation (A2886203)
30/1/24		PIF H032 Chalumbin BS1356 cable and terminations
31/10/24		H032 Chalumbin Electrical Condition Assessment Report Rev 2 (A5638035)
9/10/19		H032 Chalumbin Secondary Systems Condition Assessment Report (A3245187)

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, 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]
Strategist – HV/Digital Asset Strategies	[REDACTED]
Planner – Main/Regional Grid	[REDACTED]
Manager Projects	[REDACTED]
Project Manager	[REDACTED]
Design Manager	TBA

Project Details

1. Project Need & Objective

Chalumbin Substation is located in Far North Queensland (FNQ) and has 275 and 132kV operating voltages in one yard. Chalumbin Substation is connected via four 275kV feeders and is the major substation in the 275kV power transfer corridor between Central Queensland and FNQ. There are two 275/132kV transformers located in Chalumbin enabling power transfer into the local 132 kV network in the Cairns region through four 132kV feeders.

Chalumbin Substation was established in 1988. The majority of Primary equipment was part of the original installation and is now approaching 40 years of life. A condition assessment was carried out in 2020 and identified issues related to selected primary plant with replacement recommended in the next 5 to 10 years.

The substation has undergone feeder and bay extensions and modifications since its original construction, that has resulted in the staged installation of secondary systems from 2004 to 2014. A condition assessment conducted in 2019 has identified that the 132kV secondary systems installed in demountable building +4 in 2012 is due for replacement by 2032. In addition to the 132kV secondary systems, selected 275kV secondary systems also require replacement by this time.

The objective of this project is to replace selected 275kV primary plant and secondary systems and Built Section 1356 cables and associated sealing ends at Chalumbin substation by November 2030. This project will be executed in conjunction with CP.03144 Chalumbin 132kV Substation Reinvestment project.

This project will follow the two (2) stage approval process and is subject to a RIT-T.

2. Project Drawing

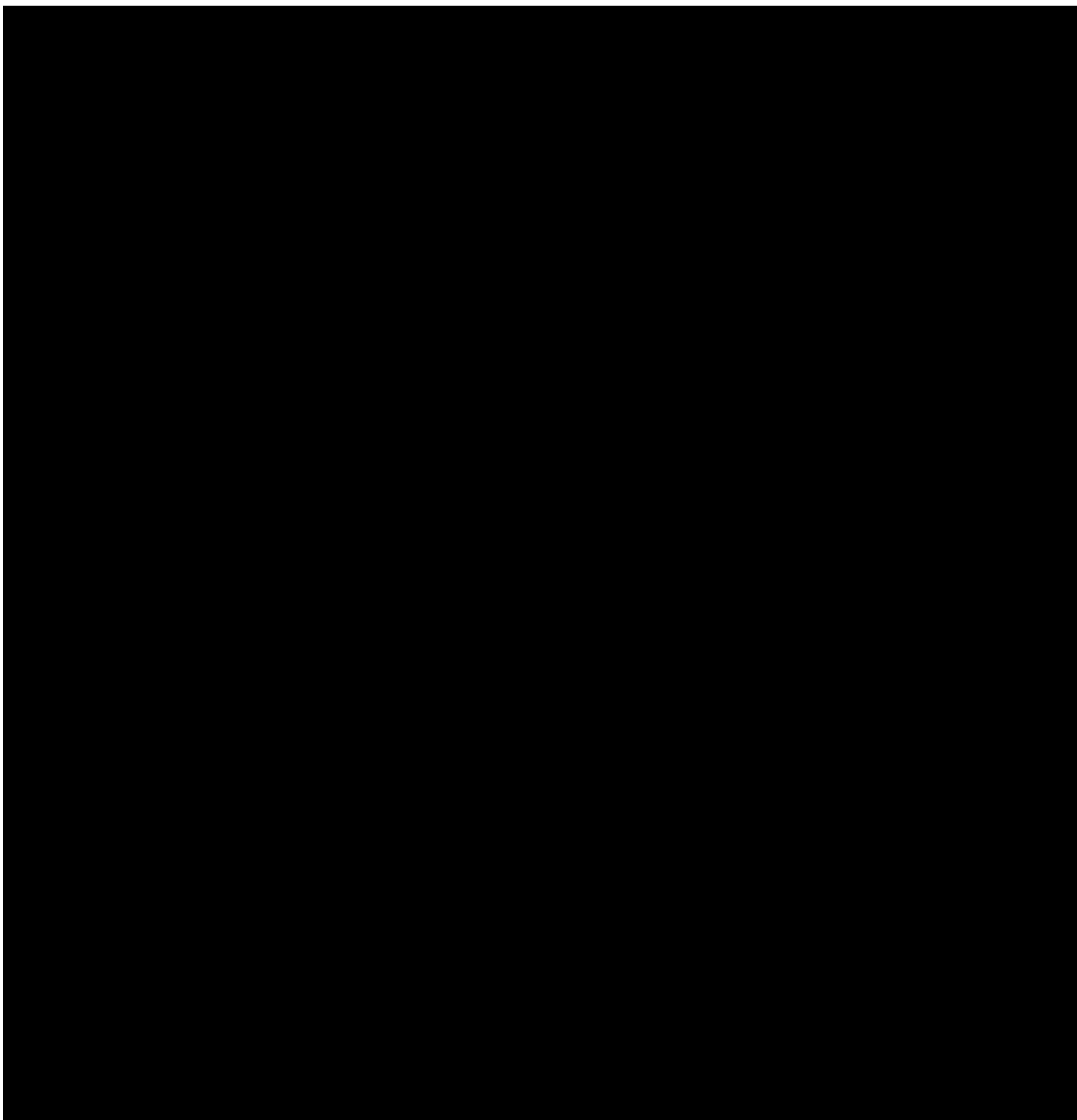


Figure 1: Chalumbin 275kV and 132kV Operating Diagram

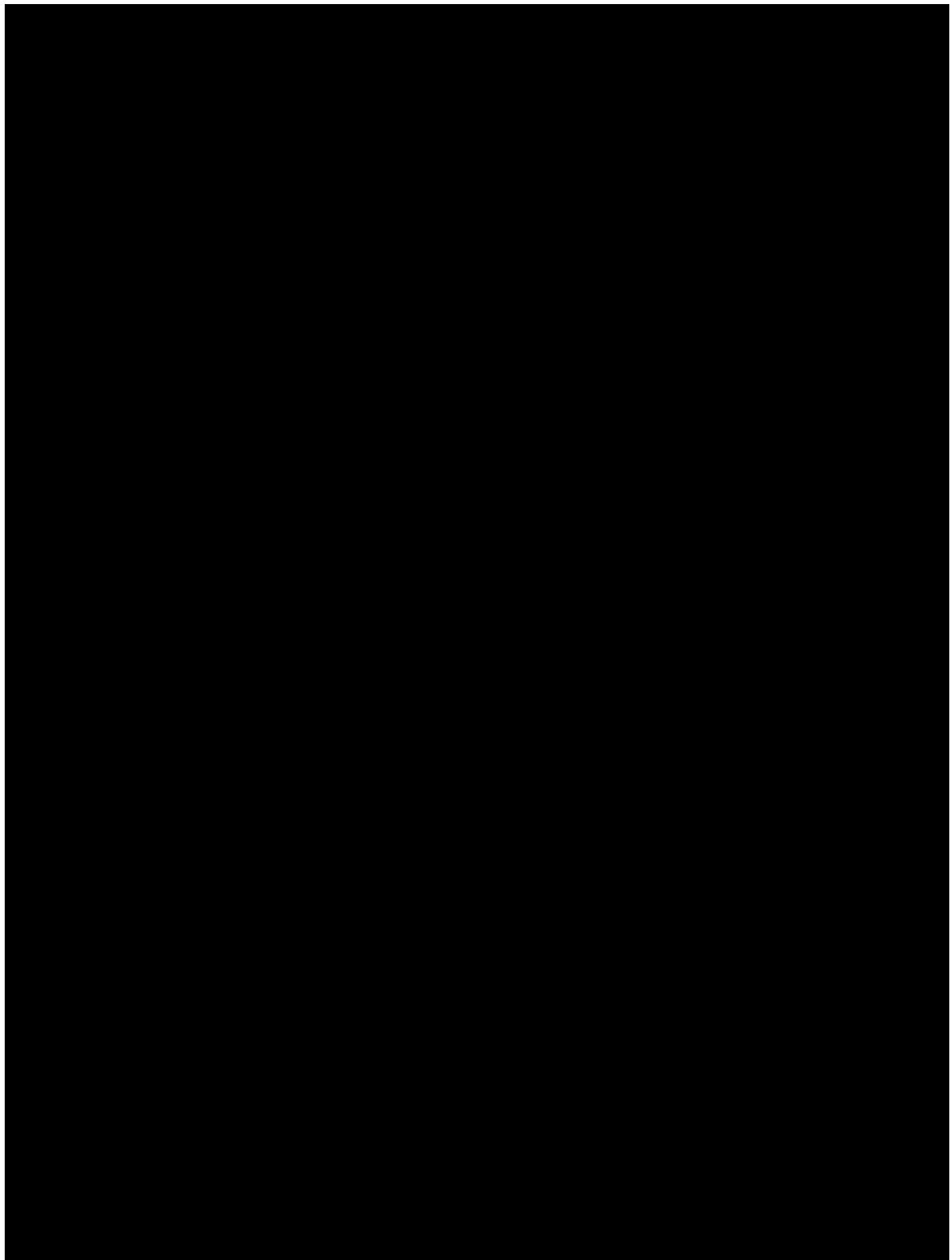


Figure 3: Chalumbin 275kV Electrical Plant Plan



Figure 4: Chalumbin Substation Aerial View

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 required for RIT-T purposes and Stage 1 approval for the preferred option only:

1. A report (e.g. Project Proposal) detailing the works to be delivered, proposed staging of delivery, resource requirements and confirmation of availability, and outage requirements
2. A class 3 estimate (minimum), based upon published design advices detailing key design elements
3. A basis of estimate document and risk table, detailing the key estimating assumptions and delivery risks
4. A detailed project staging and outage plan that includes primary plant, secondary systems and telecoms outages
5. As the project is subject to the RIT-T process, prepare a cost comparison between the selected option for this class 3 estimate and other options estimated during concept phase, outlining major cost differences at a high level
6. As this project will follow the two (2) stage approval process, provide a separate estimate for stage 2 development phase costs which include project planning, design and preliminary works. Also provide the schedule and time information to align with 2-stage approval.

4. Project Scope

4.1. Scope Overview and Options

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 replacing selected 275kV primary plant and secondary systems, and Built Section 1356 cables and associated sealing ends at Chalumbin substation.

Two credible options have been identified to replace selected equipment at Chalumbin substation, as presented in Table 1 below. These options will be presented in the RIT-T public consultation (a combined RIT-T will be undertaken for CP.02948 and CP.03144).

Concept estimates have been completed for each option to inform feasibility and cost assessments and Option 1 has been selected as the preferred option.

Table 1 - Options summary

Option	Stage	Works	Comm. Date
1	1	Replace selected 275kV primary plant, Built Section 1356 cables and associated sealing ends.	
1	1	Replace selected secondary systems equipment within the existing +1 building. Assessment to be undertaken by the project team to confirm whether installation of new panels in the existing buildings or in-situ replacement of devices within existing panels is the preferred approach.	Nov 2030
2	1	Replace selected 275kV primary plant, Built Section 1356 cables and associated sealing ends.	Oct 2029
2	2	Replace selected secondary systems equipment within the existing +1 building. Assessment to be undertaken by the project team to confirm whether installation of new panels in the existing buildings or in-situ replacement of devices within existing panels is the preferred approach.	Feb 2034

4.1.1. Transmission Line Works

Not applicable.

4.1.2. H032 Chalumbin Substation Works

Primary Works

Design, procure, construct and commission the replacement of the selected 275kV 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; and

- Existing structures and foundations are to be reused where possible, ensuring they are fit for purpose for a minimum of 40 years.

Install new Surge Arrestors in bay C06-Q10 (existing foundations to be assessed and used if possible).

Decommission and remove obsolete primary plant listed in Attachment 2.

Design, procure, construct and commission the replacement of Built Section 1356, including:

- Replace the Transformer 1 tertiary compound filled cable box with an air cable box with necessary modifications;
- Replace the existing 19/33kV underground cables from Transformer 1 tertiary to the cable termination structures;
- Replace the transition end 33kV termination; and
- Undertake all associated civil works.

Secondary Works:

Design, procure, construct and commission new 275kV secondary systems within the existing control buildings for the following plant:

- 275kV coupler 503 (C03-Q30);
- 275kV coupler 504 (C04-Q30);
- 275/132kV T1 (C03-Q20) and T2 (C04-Q20);
- 275kV bus reactor M05 (C05-Q10);
- 275kV Feeder 857 reactor M2 (C03-Q40);
- 275kV Feeder 858 reactor M3 (C04-Q40);
- 1T 19kV Reactor F1;
- Duplicated WAMPAC infrastructure to monitor all 275kV feeder statuses;
- OpsWAN and SCADA to provide for control and monitoring requirements including OpsWAN equipment (except the camera) and relocate devices (except the camera) from the OpsWAN camera housing at the top of the pole to the camera patch box at the base of the pole;
- Replace 125V and 50V DC charges and monitoring systems (battery banks were replaced in 2023 under CP.02786);
- Modify AC and DC distribution as required to facilitate the replacement works; and
- Modify and upgrade telecommunications equipment as required to support the new secondary systems;

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

4.1.3. Remote End Substation Works

Modify protection, control, automation and communications systems as required at all impacted remote end substations.

4.1.4. Telecoms Works

Telecoms works included under Substation Works.

Telecommunications works are to be coordinated with CP.02811 Telecommunication Network Consolidation RAN 2 and CP.02513 OpsWAN and MPLS Replacement RAN 2. It is expected that works under CP.02811 and CP.02513 will be completed at Chalumbin prior to commencing the secondary systems cutovers, however, this needs to be confirmed with the project team.

4.1.5. Easement/Land Acquisition & Permits Works

Not applicable

4.2. Key Scope Assumptions

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

- This project will be executed in conjunction with CP.03144 Chalumbin 132kV Substation Reinvestment;
- Telecommunications works under CP.02811 Telecommunication Network Consolidation RAN 2 and CP.02513 OpsWAN and MPLS Replacement RAN 2 will be completed at Chalumbin prior to commencing the secondary systems cutovers.
- The following ABB IMB300 CTs will be replaced under CP.03104 Replace ABB IMB300 CTs – Northern prior to commencing site works under this project:

Functional Location	Equipment Id	Manufacturer	Model	Tech Type
H032-C03-541--1TRFCTA	20075967	ABB	IMB300C5H3	SUBS0015
H032-C03-541--1TRFCTB	20075966	ABB	IMB300C5H3	SUBS0015
H032-C03-541--1TRFCTC	20075968	ABB	IMB300C5H3	SUBS0015

4.3. Variations to Scope (post project approval)

Not applicable

5. Key Asset Risks

From an asset risk perspective, priority is to be given to the ASEA CVTs as these are at risk of explosive failure.

Functional Location	Equipment Id	Manufacturer	Model	Tech Type
H032-C06-8932-13VTA	20014145	ASEA	CPEE300F-C	SUBS0009
H032-C06-8932-13VTB	20012969	ASEA	CPEE300F-C	SUBS0009
H032-C06-8932-13VTC	20012970	ASEA	CPEE300F-C	SUBS0009

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 April 2026.

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 31st November 2030.

The project team are to advise the Sponsor as soon as possible if preapproval funding is required to procure long lead time equipment before completion of the estimate to meet the proposed commissioning date.

7. Special Considerations

- For BS1356 replacement works, the compound must be removed from the existing cable box and cleaned thoroughly to prevent further contamination. The recovered compound must be disposed of in accordance with the relevant environmental standards.
- Cables, marshalling kiosks and panels are in good condition and do not require replacement. Design to undertake site assessment and determine most appropriate replacement methodology utilising the existing buildings i.e. new panels in the existing buildings or in-situ device replacement within the existing panels. Assessment, including reasons for recommended approach to be provided as part of the Concept Estimate.

8. Asset Management Requirements

Equipment shall be in accordance with Powerlink equipment strategies.

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

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.

[REDACTED]

11. Options

As per section 4

12. Division of Responsibilities

Not applicable

13. Related Projects

Project No.	Project Description	Planned Comm Date	Comment
Pre-requisite Projects			
CP.02786	Chalumbin Secondary Systems Replacement Stage 1	Dec 2025	In execution
CP.03104	Replace 275kV ABB IMB300 CT's - Northern	2029	Definition
Co-requisite Projects			
CP.03144	Chalumbin 132kV Substation Reinvestment	2028	Definition
CP.02811	Telecommunication Network Consolidation RAN 2	Dec 2027	Definition
CP.02513	CP.02513 OpsWAN and MPLS Replacement RAN 2	Aug 2027	Definition
Other Related Projects			
CP.02750	BS1220 Ross to Chalumbin Life Extension	2029	Definition

Attachment 1: Primary Plant to be replaced under CP.02948

Functional Location	Equipment Id	Manufacturer	Model	Tech Type
H032-C03-503--5032	20005250	ASEA	HPL300/25B1 SPAR P	SUBS0010
H032-C03-503--5032CTA	20005274	HAEFELY	IOSK300/1050	SUBS0015
H032-C03-503--5032CTB	20005272	HAEFELY	IOSK300/1050	SUBS0015
H032-C03-503--5032CTC	20005270	HAEFELY	IOSK300/1050	SUBS0015
H032-C03-541--1SAA	20005310	ASEA	XAQ300A2/240	SUBS0031
H032-C03-541--1SAB	20005309	ASEA	XAQ300A2/240	SUBS0031
H032-C03-541--1SAC	20005308	ASEA	XAQ300A2/240	SUBS0031
H032-C03-857--1VTA	20036347	HAEFELY TRENCH	TEMP287	SUBS0009
H032-C03-857--1VTB	20036346	HAEFELY TRENCH	TEMP287	SUBS0009
H032-C03-857--1VTC	20036345	HAEFELY TRENCH	TEMP287	SUBS0009
H032-C03-857--2VTB	20045065	TRENCH LIMITED	TEMP287	SUBS0009
H032-C03-857--857RESAA	20005313	ASEA	XAQ300A2/240	SUBS0031
H032-C03-857--857RESAB	20005312	ASEA	XAQ300A2/240	SUBS0031
H032-C03-857--857RESAC	20005311	ASEA	XAQ300A2/240	SUBS0031
H032-C03-857--857SAA	20005307	ASEA	XAP300A2/240	SUBS0031
H032-C03-857--857SAB	20005306	ASEA	XAP300A2/240	SUBS0031
H032-C03-857--857SAC	20005305	ASEA	XAP300A2/240	SUBS0031
H032-C04-858--9VTB	20066812	TRENCH LIMITED	TEMP287C	SUBS0009
H032-C06-876--19VTA	20056267	TRENCH LIMITED	TEMP287	SUBS0009
H032-C06-876--19VTB	20056268	TRENCH LIMITED	TEMP287	SUBS0009
H032-C06-876--19VTC	20056269	TRENCH LIMITED	TEMP287	SUBS0009
H032-C06-8932-13VTA	20014145	ASEA	CPEE300F-C	SUBS0009
H032-C06-8932-13VTB	20012969	ASEA	CPEE300F-C	SUBS0009
H032-C06-8932-13VTC	20012970	ASEA	CPEE300F-C	SUBS0009
H032-C06-8932-18VTB	20045070	TRENCH LIMITED	TEMP287	SUBS0009
H032-KC--KC1--14VTA	20045067	TRENCH LIMITED	TEMP287	SUBS0009
H032-KC--KC1--14VTB	20045068	TRENCH LIMITED	TEMP287	SUBS0009
H032-KC--KC1--14VTC	20045069	TRENCH LIMITED	TEMP287	SUBS0009
H032-KC--KC2--15VTA	20045062	TRENCH LIMITED	TEMP287	SUBS0009
H032-KC--KC2--15VTB	20045063	TRENCH LIMITED	TEMP287	SUBS0009
H032-KC--KC2--15VTC	20045064	TRENCH LIMITED	TEMP287	SUBS0009
H032-T01-1TRF-1TRFCTA	20011977	TYREE	06/36/150	SUBS0015
H032-T01-1TRF-1TRFCTB	20005259	TYREE	06/36/150	SUBS0015

H032-T01-1TRF-1TRFCTC	20005258	TYREE	06/36/150	SUBS0015
H032-T01-1TRF-1TRFNCTA	20005260	TYREE	06/36/149	SUBS0015
H032-T01-1TRF-1TRFNCTC	20005257	TYREE	06/36/149	SUBS0015
H032-C04-858—858RESAA	20005300	ABB	EXLIM Q240	SUBS0031
H032-C04-858—858RESAB	20005301	ABB	EXLIM Q240	SUBS0031
H032-C04-858—858RESAC	20005302	ABB	EXLIM Q240	SUBS0031
H032-C04-858—858SAA	20005303	ABB	EXLIM Q240	SUBS0031
H032-C04-858—858SAB	20013014	ABB	EXLIM Q240	SUBS0031
H032-C04-858—858SAC	20005304	ABB	EXLIM Q240	SUBS0031

Attachment 2: Primary Plant to be decommissioned under CP.02948

Functional Location	Equipment Id	Manufacturer	Model	Tech Type
H032-C03-857--857CDB	20049932	TRENCH ELECTRIC	K9514XS	SUBS0013
H032-C03-857--857CDC	20049933	TRENCH ELECTRIC	K9514XS	SUBS0013



CP.02948 H032 Chalumbin 275kV Substation Reinvestment

Concept Estimate

Current version: 7/04/2025	INTERNAL USE	Page 1 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland

Table of Contents

1. Executive Summary	3
2. Project Information	4
2.1 Option Comparison Table.....	4
2.2 Dependencies & Interactions.....	5
2.3 Site Specific Issues	6
2.4 Project Milestones	8
3. Option 1 – Replace Primary Plant and Secondary Systems Together	9
3.1 Option Definition	9
3.1.1 Option High-Level Scope.....	9
3.1.2 Scope Assumptions	10
3.1.3 Scope Exclusions	11
3.2 Project Execution.....	12
3.2.1 Project Schedule.....	12
3.2.2 Network Impacts	12
3.2.3 Resourcing.....	13
3.3 Project Estimate.....	13
4. Option 2 – Staged Primary Plant and Secondary Systems Replacement.....	14
4.1 Option Definition	14
4.1.1 Option Scope.....	14
4.1.2 Scope Assumptions.....	15
4.1.3 Scope Exclusions	16
4.2 Project Execution.....	16
4.2.1 Project Schedule.....	16
4.2.2 Network Impacts	17
4.2.3 Resourcing.....	17
4.3 Project Estimate.....	18
5. Project Risk	19
6. References.....	21



1. Executive Summary

This concept estimate has been developed based on the CP.02948 – H032 Chalumbin 275 kV Substation Reinvestment Project Scope Report (PSR).

Chalumbin Substation (H032) is located in Far North Queensland (FNQ) and has 275kV and 132kV operating voltages in a single yard. Chalumbin Substation is connected via four 275kV feeders and is the major substation in the 275kV power transfer corridor between Central Queensland and FNQ. There are two 275/132kV transformers located in Chalumbin enabling power transfer into the local 132kV network in the Cairns region via four 132kV feeders.

The Substation was established in 1988. Most of the Primary equipment was part of the original installation and is now approximately 37 years old. A condition assessment was carried out in 2020 and identified issues related to selected primary plant with replacement recommended in the next 5 to 10 years.

The substation has undergone feeder and bay extensions and modifications since its original construction, that has resulted in the staged installation of secondary systems from 2004 to 2014. A condition assessment conducted in 2019 has identified that the 132kV secondary systems installed in demountable building +4 in 2012 is due for replacement by 2032. In addition to the 132kV secondary systems, selected 275kV secondary systems also require replacement by this time.

This project consists of replacing selected 275kV primary plant, secondary systems and Built Section 1356 cables and associated sealing ends at Chalumbin substation.

This concept report explores the two options detailed in the project scope report:

- **Option 1:** Replace both selected 275kV Primary Plant and Secondary Systems concurrently. The new secondary systems panels have been allowed to be installed in the existing control building.
- **Option 2:** A two staged approach with the replacement of the selected 275kV Primary Plant to be completed in stage one and the replacement of the Secondary Systems in stage two. The new secondary systems panels have been allowed to be installed in the existing control building.

The assessment from the project team has determined that the project can be delivered by **November 2030** for **Option 1** and **February 2034** for **Option 2**.

Estimates are provided for each option to inform the feasibility of the project and to develop the basis for external consultation under the Regulatory Investment Test for Transmission (RIT-T). This project will follow the two (2) stage approval process.

Current version: 7/04/2025	INTERNAL USE	Page 3 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland

2. Project Information

2.1 Option Comparison Table

	Option 1 - Replace Primary Plant and Secondary Systems Together	Option 2 - Staged Primary Plant and Secondary Systems Replacement
Cost (total escalated including contingency)	<ul style="list-style-type: none"> Total Requested Approved Budget - \$45,942,255 	<ul style="list-style-type: none"> Total Requested Approved Budget - \$62,156,004
Commissioning Date	<ul style="list-style-type: none"> November 2030 	<ul style="list-style-type: none"> February 2034
Stages Requiring HV Outages	<ul style="list-style-type: none"> 13 - totalling 89 weeks 	<ul style="list-style-type: none"> 22 - totalling 145 weeks
Execution Strategy Advantages	<ul style="list-style-type: none"> Primary plant and secondary systems to be replaced together, reducing demobilisation / remobilisation, labour and escalation costs (due to project prolongation). 	<ul style="list-style-type: none"> Extends the operational life of the secondary systems equipment.
Execution Strategy Disadvantages	<ul style="list-style-type: none"> Replacing primary plant and secondary systems at the same time increases the technical complexity of the scope and introduces additional risk. 	<ul style="list-style-type: none"> Additional demobilisation / remobilisation, labour and project escalation costs (due to project prolongation). Higher impact from seasonal weather events and Network Operations outage restrictions. Possibility of new secondary systems standards being developed over the extended project delivery timeline.
Weather / Network Operations Delay Periods	<ul style="list-style-type: none"> 5 - totalling 65 weeks. 	<ul style="list-style-type: none"> 11 - totalling 142 weeks
Site Mobilisation events required	<ul style="list-style-type: none"> 4 	<ul style="list-style-type: none"> 9
Site Demobilisation events required	<ul style="list-style-type: none"> 4 	<ul style="list-style-type: none"> 9

Current version: 7/04/2025	INTERNAL USE	Page 4 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland



2.2 Dependencies & Interactions

This project is dependent on the following projects:

Project No.	Project Description	Planned Comm Date	Comment
Pre-requisite Projects			
CP.02786	Chalumbin Secondary Systems Replacement Stage 1	July 2027	This project is the first stage of the 275kV Secondary Systems replacement. Resources will be retained to start CP.02948/CP.03144 immediately upon project completion.
CP.03104	Replace 275kV ABB IMB300 CT's - Northern	2026	T1 CT's to be replaced prior to site mobilisation.
Co-requisite Projects			
CP.03144	Chalumbin 132kV Substation Reinvestment	TBC	CP.03144 is planned to be delivered in conjunction with CP.02948 to optimise resource utilisation on site.
CP.02811	Telecommunication Network Consolidation RAN 2	Dec 2027	Project is expected to be completed prior to mobilisation, project teams to monitor.
CP.02513	CP.02513 OpsWAN and MPLS Replacement RAN 2	Aug 2027	Project is expected to be completed prior to mobilisation, project teams to monitor.
Other Related Projects			
CP.02750	BS1220 Ross to Chalumbin Life Extension	2029	Project on the transmission feeders is planned in the same time period, opportunity to combine outages where possible.

Current version: 7/04/2025	INTERNAL USE	Page 5 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland

2.3 Site Specific Issues



Figure 1: H032 Chalumbin Substation

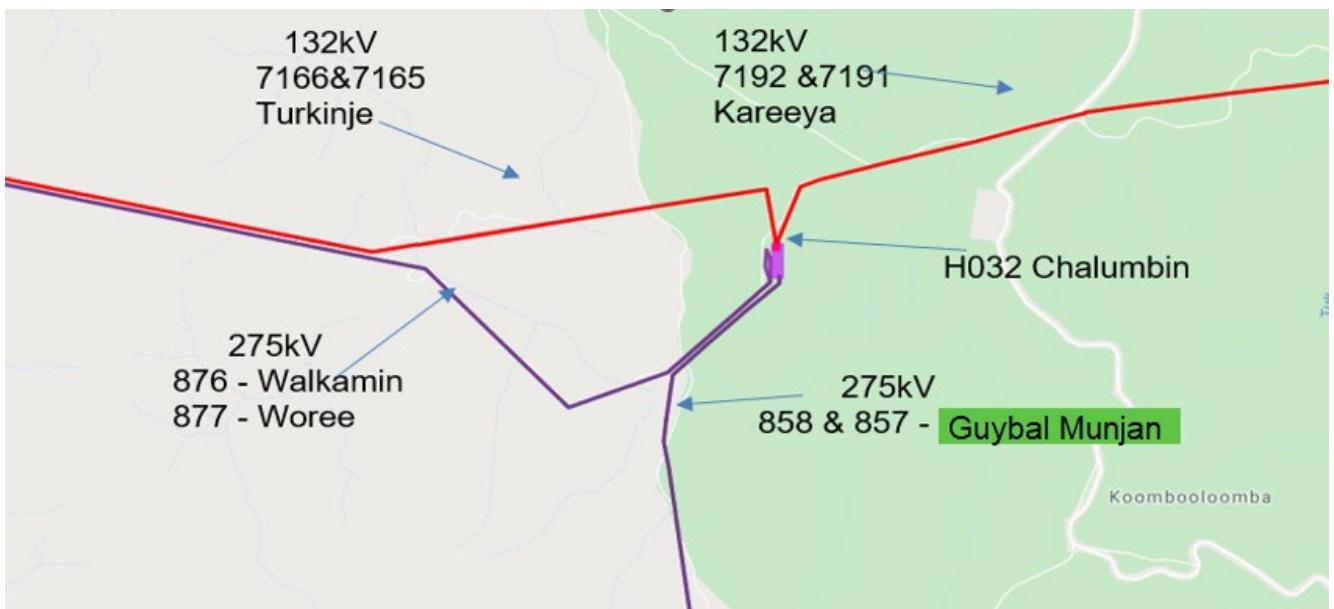


Figure 2: Overview of HV Supply Network

Issues specific to the project are as follows:

Current version: 7/04/2025	INTERNAL USE	Page 6 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland

- The work site is located in the Einasleigh Uplands region on the western edge of Tully Falls National Park and adjacent to Koombooloomba Dam which is 2h 40m and 172km from Cairns Airport.
 - Teams should avoid the Gillies Range route for deliveries from the Cairns region due to accessibility limitations.
 - There is limited accommodation in the area with teams needing to stay in Ravenshoe, approximately 40-50km and 30 minutes from site.
 - The closest concrete batching plant is also in Ravenshoe.
 - Mobile phone reception can be limited.
- H032 has 4 x 132kV and 4 x 275kV Feeders.
 - 2 x 132kV Feeders to Turkinje.
 - 2 x 132kV Feeders to Kareeya.
 - 2 x 275kV Feeders to Guybal Munjan.
 - 1 x 275kV Feeder to Walkamin.
 - 1 x 275kV Feeder to Woree.
- Chalumbin substation experiences a humid, high-rainfall climate and is located in the Wet Tropics zone, characterized by a summer monsoon (wet season) and a milder dry season. Below is a summary of the average monthly rainfall based on long-term BOM records from the nearby Koombooloomba Dam gauge (which is representative of the substation's location):

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature													
Mean maximum temperature (°C)	27.9	27.0	25.9	23.5	21.5	20.1	19.6	20.8	23.5	25.5	27.9	28.4	24.3
Mean minimum temperature (°C)	19.1	19.3	18.5	17.1	15.1	11.5	11.1	11.7	13.3	15.5	17.3	18.5	15.7
Rainfall													
Mean rainfall (mm)	343.6	468.8	480.2	359.0	238.0	150.5	124.6	100.4	82.6	94.7	120.3	188.7	2753.9
Decile 5 (median) rainfall (mm)	277.6	413.0	396.6	323.0	241.3	128.9	111.9	58.8	40.1	68.2	110.6	159.1	
Mean number of days of rain ≥ 1 mm	14.5	15.6	16.6	16.0	14.2	10.0	9.5	8.4	6.2	6.8	8.1	10.4	136.3

Figure 3: Climate Statistics for Koombooloomba Dam

- Due to the high rainfall (December – March), any stages requiring civil works to be carried out have been scheduled to avoid this period for all options.
- Due to the outage restrictions imposed by Network Operations, HV outages have been planned within shoulder periods (15/03-30/06 and 18/08-10/10), greatly extending the project durations for both brownfield options 1 and 2.

Current version: 7/04/2025	INTERNAL USE	Page 7 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland



2.4 Project Milestones

Milestones	High Level Timing (Milestone Completion Date)
Request for Class 3 Estimate	September 2025
Class 3 Project Proposal	March 2026
Stage 1 Approval (PAN1) incl funds for design, procurement & ITT preparation	April 2026
RIT-T Issued	April 2026
Project Development Phase 1 & Phase 2	September 2026
Endorsement for Issuing Tender from Network & Alternate Solutions	September 2026
RIT-T Approval (assumed 26 weeks)	October 2026
ITT Submission (6 weeks)	October 2026
Evaluate Tender, Reconcile Estimate and Update PMP for Stage 2 Approval	November 2026
Stage 2 Approval (PAN2)	March 2027
Execute Delivery (including award of SPA contract)	April 2027

Current version: 7/04/2025	INTERNAL USE	Page 8 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland

3. Option 1 – Replace Primary Plant and Secondary Systems Together

3.1 Option Definition

3.1.1 Option High-Level Scope

Replacement of both Primary Plant and Secondary Systems Works together (see *Figure 4: 275kV Line Diagram* for reference).

- 300kV Dead Tank Circuit Breaker (x1).
- 300kV Capacitor Voltage Transformer (x18).
- 240kV Surge Arrester (x18).
- 36kV Current Transformer (x5).
- Replacement of Built Section 1356 including:
 - Replace the Transformer 1 tertiary compound filled cable box including necessary modifications.
 - Replace the existing 33/19kV underground cables from Transformer 1 tertiary to the cable termination structures.
 - Undertake all associated civil works.

Replacement of secondary systems utilising 10 new panels in the existing +1 building.

- 275kV coupler 503 (C03-Q30).
- 275kV coupler 504 (C04-Q30).
- 275/132kV T1 (C03-Q20).
- 275/132kV T2 (C04-Q20).
- 275kV Feeder 857 reactor M2 (C03-Q40).
- 275kV Feeder 858 reactor M3 (C04-Q40).
- 1T 19kV Reactor F1.
- Duplicated WAMPAC infrastructure to monitor all 275kV feeder statuses.
- OpsWAN and SCADA to provide for control and monitoring requirements including OpsWAN equipment (except the camera) and relocate devices (except the camera) from the OpsWAN camera housing at the top of the pole to the camera patch box at the base of the pole.
- Replace 125V and 50V DC chargers and monitoring systems only (battery banks were replaced in 2023 under CP.02786).
- Modify AC and DC distribution as required to facilitate the replacement works.
- Modify and upgrade telecommunications equipment as required to support the new secondary systems.

Remote End Substation Works

Modify the protection, control, automation and communications systems as required at the remote ends of the following feeders:

- 2 x 275kV Feeders to Guybal Munjan.
- 1 x 275kV Feeder to Walkamin.
- 1 x 275kV Feeder to Tumoulin.

Telecommunications Works

Current version: 7/04/2025	INTERNAL USE	Page 9 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland



Telecommunications works are to be coordinated with CP.02811 Telecommunication Network Consolidation RAN 2 and CP.02513 OpsWAN and MPLS Replacement RAN 2. It is expected that works under CP.02811 and CP.02513 will be completed at Chalumbin prior to commencing the secondary systems cutovers.

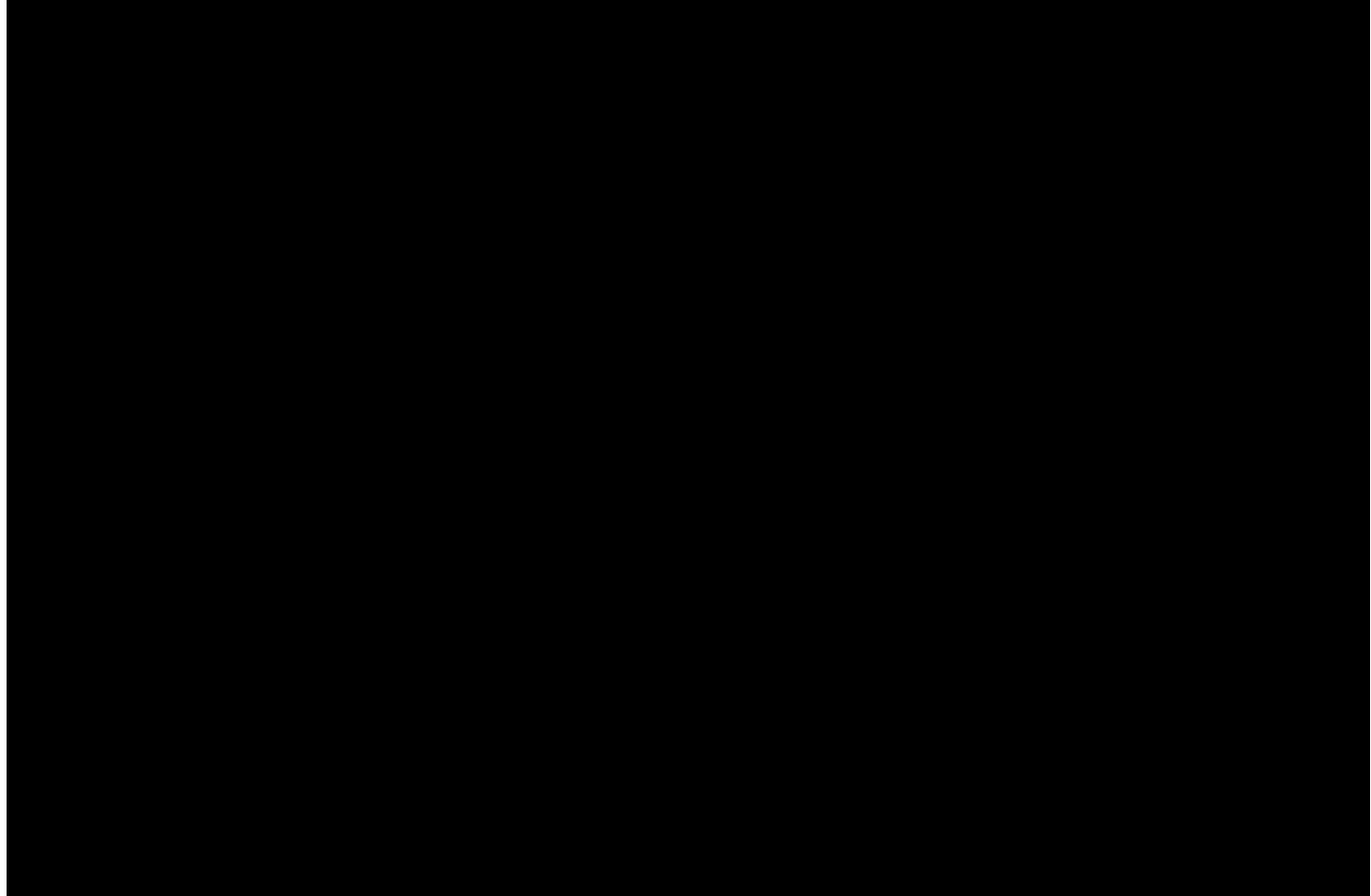


Figure 4: 275kV Line Diagram

3.1.2 Scope Assumptions

- [REDACTED]
- Allowance has been made to replace the primary equipment foundations and structures.
- Dead tank circuit breakers are to be used.
- New panels will be installed into the existing buildings.
- Cables between termination rack and marshalling kiosks are in good condition and do not require replacement.
- Marshalling kiosks are in good condition and do not require replacement.
- This project will be executed in conjunction with CP.03144 H032 Chalumbin 132kV Selective Plant Replacement.
- Telecommunications works under CP.02811 Telecommunication Network Consolidation RAN 2 and CP.02513 OpsWAN and MPLS Replacement RAN 2 will be completed at Chalumbin prior to commencing the secondary systems cutovers.
- Project Milestone dates are met as outlined in 2.4.

Current version: 7/04/2025	INTERNAL USE	Page 10 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland

- Outages will be available and any Return to Service (RTS) requirements will be agreed in a timely manner.
- MSP resourcing is available when required to meet the approved commissioning date.
- SPA contractor is available when required to meet the approved commissioning date.
- PLQ Design resources are available when required to meet the approved commissioning date.
- PLQ project and support resources are available to align with the project timing to support meeting the approved commissioning date.
- Access to site is available.
- All required scope items have been included in Revision 2 of the CP.02948 Project Scope Report issued on 24/06/2025.
- Funds will be released to purchase long lead items, undertake design and ITT (Stage 1 Approval).
- Soil conditions are generally suitable for bored, reinforced concrete structures.
- Primary Plant Materials and Secondary Systems Equipment and Materials are available on time for the construction.
- The following lead times have been considered in this estimate:

Equipment	Lead Time
275kV Dead Tank Circuit Breaker	78 weeks
CVT	78 weeks
Station Post Insulator	52 weeks
Surge Arrestors	100 weeks (investigating acceleration)
Disconnectors	60 weeks
Control Building Panels	8 weeks

3.1.3 Scope Exclusions

- Easement acquisition works, including permits, approvals, development applications etc. All works are within Powerlink owned land.
- Any outage contingency plans required by Network Operations.
- Any works on the EQL network.
- No allowance has been made for Live Substations work.
- No allowance has been made for External Design resources.
- Additional foundation work associated with high water table.
- Inclement weather in excess of what could reasonably be expected.
- Excavation in hard ground i.e. rock is excluded from this estimate.
- Any work outside of normal working hours.

Current version: 7/04/2025	INTERNAL USE	Page 11 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland

3.2 Project Execution

3.2.1 Project Schedule

Activity	Date
Early Works (by SPA)	July 2027
FAT (by MSP)	August – November 2027
M2 Reactor	August – October 2027
M3 Reactor	October – November 2027
<i>Wet Season / HV Outage Restriction</i>	<i>November 2027 – February 2028</i>
275kV Coupler 504	February – April 2028
275kV Feeder 8932	April – May 2028
275kV Feeder 876	May – June 2028
275kV Feeder 858	June – July 2028
<i>HV Outage Restriction</i>	<i>July – August 2028</i>
275kV Feeder 857	August – September 2028
275/132kV T2	September – November 2028
<i>Wet Season / HV Outage Restriction</i>	<i>November 2028 – March 2029</i>
275kV Coupler 503	April – July 2029
<i>HV Outage Restriction</i>	<i>July – August 2029</i>
275/132kV T1	August – November 2029
<i>Wet Season / HV Outage Restriction</i>	<i>November 2029 – April 2030</i>
275kV 1 Bus	April – May 2030
275kV 2 Bus	May 2030
Additional Sec Sys	May – August 2030
Remove redundant equipment	August – November 2030
Project Commissioned	November 2030

3.2.2 Network Impacts

Network Operations advised that all outages will require a 12-hour return to service (RTS) or an adequate contingency plan.

Following receipt of a Class 3 proposal request, the project team will engage in further discussions with PLQ Network Operations & EQL to discuss and agree on the proposed outages.

Current version: 7/04/2025	INTERNAL USE	Page 12 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland



The following historical outage windows do not require a 12-hour RTS and were provided by Network Operations on the CP.02786 Chalumbin Secondary Systems Replacement project. Both option 1 and 2's HV Outages have been planned around the below timeframes.

- 15/03 - 30/06
- 18/08 - 10/10

3.2.3 Resourcing

The following resource strategy is proposed:

- Design by PLQ.
- SPA construction.
- MSP (core works).
- SPA contractor may be engaged under a D&C contract, should PLQ design resources be constrained and risk delaying achieving the approved commissioning date.

3.3 Project Estimate

		Sub Total \$	Total \$
Estimate Class	5		
Estimate accuracy (+% / -%)	-50% / + 100%		
Base Estimate		\$29,874,853	

Current version: 7/04/2025	INTERNAL USE	Page 13 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland

4. Option 2 – Staged Primary Plant and Secondary Systems Replacement

4.1 Option Definition

4.1.1 Option Scope

Staged replacement of Primary Plant by October 2029 and Secondary Systems Equipment by 2034 (see *Figure 4: 275kV Line Diagram* below for reference).

- 300kV Dead Tank Circuit Breaker (x1)
- 300kV Capacitor Voltage Transformer (x18)
- 240kV Surge Arrester (x18)
- 36kv Current Transformer (x5)
- Replacement of Built Section 1356 including:
 - Replace the Transformer 1 tertiary compound filled cable box including necessary modifications.
 - Replace the existing 33/19kV underground cables from Transformer 1 tertiary to the cable termination structures.
 - Undertake all associated civil works.

Replacement of the below secondary systems utilising 10 new panels in the existing +1 building.

- 275kV coupler 503 (C03-Q30).
- 275kV coupler 504 (C04-Q30).
- 275/132kV T1 (C03-Q20)
- 275/132kV T2 (C04-Q20).
- 275kV Feeder 857 reactor M2 (C03-Q40).
- 275kV Feeder 858 reactor M3 (C04-Q40).
- 1T 19kV Reactor F1.
- Duplicated WAMPAC infrastructure to monitor all 275kV feeder statuses.
- OpsWAN and SCADA to provide for control and monitoring requirements including OpsWAN equipment (except the camera) and relocate devices (except the camera) from the OpsWAN camera housing at the top of the pole to the camera patch box at the base of the pole.
- Replace 125V and 50V DC chargers and monitoring systems only (battery banks were replaced in 2023 under CP.02786).
- Modify AC and DC distribution as required to facilitate the replacement works.
- Modify and upgrade telecommunications equipment as required to support the new secondary systems.

Remote End Substation Works

Modify the protection, control, automation and communications systems as required at the remote ends of the following feeders:

- 2 x 275kV Feeders to Guybal Munjan
- 1 x 275kV Feeder to Wilkamin
- 1 x 275kV Feeder to Tumoulin

Telecommunications Works

Current version: 7/04/2025	INTERNAL USE	Page 14 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland

Telecommunications works are to be coordinated with CP.02811 Telecommunication Network Consolidation RAN 2 and CP.02513 OpsWAN and MPLS Replacement RAN 2. It is expected that works under CP.02811 and CP.02513 will be completed at Chalumbin prior to commencing the secondary systems cutovers.

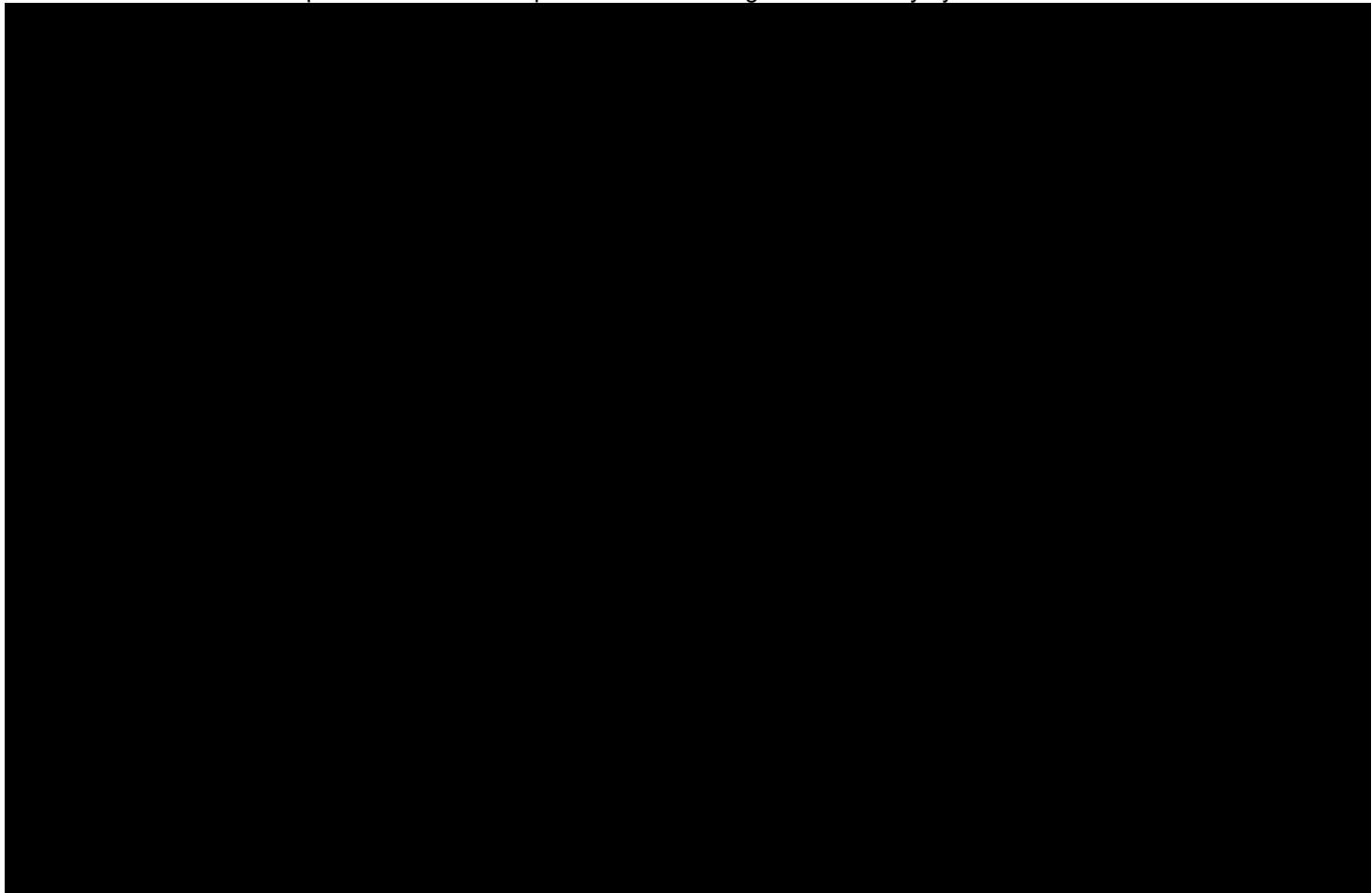


Figure 5: 275kV Line Diagram

4.1.2 Scope Assumptions

- ABB IMB300 CTs currently under RAZ will be replaced under CP.03104 Replace ABB IMB300 CTs – Northern prior to commencing site works under this project.
- Allowance has been made to replace the primary equipment foundations and structures.
- Dead tank circuit breakers are to be used.
- New panels will be installed into the existing buildings.
- Cables between termination rack and marshalling kiosks are in good condition and do not require replacement.
- Marshalling kiosks are in good condition and do not require replacement.
- This project will be executed in conjunction with CP.03144 H032 Chalumbin 132kV Selective Plant Replacement.
- Telecommunications works under CP.02811 Telecommunication Network Consolidation RAN 2 and CP.02513 OpsWAN and MPLS Replacement RAN 2 will be completed at Chalumbin prior to commencing the secondary systems cutovers.
- Project Milestone dates are met as outlined in 2.4.

Current version: 7/04/2025	INTERNAL USE	Page 15 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland

- Outages will be available and any Return to Service (RTS) requirements will be agreed in a timely manner.
- MSP resourcing is available when required to meet the approved commissioning date.
- SPA contractor is available when required to meet the approved commissioning date.
- PLQ Design resources are available when required to meet the approved commissioning date.
- PLQ project and support resources are available to align with the project timing to support meeting the approved commissioning date.
- Access to site is available.
- All required scope items have been included in Revision 2 of the CP.02948 Project Scope Report issued on 24/06/2025.
- Funds will be released to purchase long lead items, undertake design and ITT (Stage 1 Approval).
- Soil conditions are generally suitable for bored, reinforced concrete structures.
- Primary Plant Materials and Secondary Systems Equipment and Materials are available on time for the construction.
- The following lead times have been considered in this estimate:

Equipment	Lead Time
275kV Dead Tank Circuit Breaker	78 weeks
CVT	78 weeks
Station Post Insulator	52 weeks
Surge Arrestors	100 weeks (investigating acceleration)
Disconnectors	60 weeks
Control Building Panels	8 weeks

4.1.3 Scope Exclusions

- Easement acquisition works, including permits, approvals, development applications etc. All works are within Powerlink owned land.
- Any outage contingency plans required by Network Operations.
- Any works on the EQL network.
- No allowance has been made for Live Substations work.
- No allowance has been made for External Design resources.
- Additional foundation work associated with high water table.
- Inclement weather in excess of what could reasonably be expected.
- Excavation in hard ground i.e. rock is excluded from this estimate.
- Any work outside of normal working hours.

4.2 Project Execution

4.2.1 Project Schedule

Activity	Date
Current version: 7/04/2025	INTERNAL USE
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED

Early Works (by SPA)	July 2027
FAT (by MSP)	July – November 2027
M2 Reactor	August – October 2027
<i>Wet Season / HV Outage Restriction</i>	<i>October 2027 – March 2028</i>
275kV Feeder 8932	March – April 2028
275kV Feeder 876	April – May 2028
275kV Feeder 858	May 2028
275kV Feeder 857	May – June 2028
<i>HV Outage Restriction</i>	<i>June – August 2028</i>
275kV Coupler 503	August – November
<i>Wet Season / HV Outage Restriction</i>	<i>November 2028 – March 2029</i>
275/132kV T1	March – June 2029
<i>HV Outage Restriction</i>	<i>June – August 2029</i>
275kV 1 Bus	August – September 2029
275kV 2 Bus	September 2029
Staging Break	October 2029– February 2030
Secondary Systems Replacement (refer to option 2 project schedule for further detail)	February 2030 – February 2034
Project Commissioned	February 2034

4.2.2 Network Impacts

Network Operations advised that all outages would require a 12-hour return to service (RTS) or an adequate contingency plan.

Following receipt of a Class 3 proposal request, the project team will engage in further discussions with PLQ Network Operations & EQL to discuss and agree on the proposed outages.

The following historical outage windows do not require a 12-hour RTS and were provided by Network Operations on the CP.02786 Chalumbin Secondary Systems Replacement project. Both option 1 and 2's HV Outages have been planned around the below timeframes.

- 15/03 - 30/06
- 18/08 - 10/10

4.2.3 Resourcing

The following resource strategy is proposed:

- Design by PLQ.

Current version: 7/04/2025	INTERNAL USE	Page 17 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland



- SPA construction.
- MSP (core works).
- SPA contractor may be engaged under a D&C contract, should PLQ design resources be constrained and risk delaying achieving the approved commissioning date.

4.3 Project Estimate

		Sub Total \$	Total \$
Estimate Class	5		
Estimate accuracy (+% / -%)	-50% / +100%		
Base Estimate		\$39,504,917	

Current version: 7/04/2025	INTERNAL USE	Page 18 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland

5. Project Risk

Risks	Impact	Likelihood	Mitigation Strategy
Availability of Resources: <ul style="list-style-type: none"> • Contractor • MSP 	Major	Moderate	Engage in early and ongoing discussions with Network Operations (Net Ops) and Customers to identify and secure required resources. Establish contingency workforce planning.
Change in project delivery strategy due to: <ul style="list-style-type: none"> • Network Outage Change • Staging Change • Design; Management of Change • Latent conditions (e.g. unforeseen site issues) 	Major	Possible	Conduct ongoing reviews of the overall delivery strategy, staging plans, outage planning, and design changes. Build flexibility into the project schedule and budget.
Substation Scope of Works: Pending confirmation of "No Recall" outage timeframes	Major	Possible	Coordinate closely with Net Ops for early confirmation of outage timeframes. Develop alternative construction methodologies if timeframes are not met.
Procurement Delays / Equipment Availability: Long lead times due to market conditions or supplier issues	Major	Possible	Secure early funding and initiate procurement early to lock in delivery dates. Maintain a list of alternate vendors or substitute equipment if needed.
Inclement weather during Construction	Major	Likely	Schedule critical path construction activities outside the wet season (December – March). Build weather contingencies into the timeline and budget.
RIT-T process (assumed duration 26 weeks):	Major	Possible	Maintain regular communication with the project Sponsor and regulatory teams. Develop contingency commissioning scenarios if RIT-T is delayed.
Design and Delivery Changes: <ul style="list-style-type: none"> • Scope maturity • Late design changes • Outage staging modifications • MSP resource fluctuations 	Major	Possible	Confirm contractual commitments early. Implement scope freeze dates and stage-gate reviews to control change. Engage early with third-party contractors and Subject Matter Experts (SMEs).

Current version: 7/04/2025	INTERNAL USE	Page 19 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland



Safety Incidents / WHS Non-compliance	Major	Unlikely	Implement Safety Management Plans. Conduct regular training, audits, and toolbox talks. Ensure all contractors adhere to company safety procedures and reporting.
Cost Overruns due to Market Price Escalation	Moderate	Possible	Include risk allowances and escalation contingencies in the project budget. Monitor market trends and renegotiate supply contracts where feasible.
Regulatory or Legislative Change	Moderate	Unlikely	Monitor regulatory environment through legal and compliance teams. Adapt project plans to remain compliant with any new regulations.

Current version: 7/04/2025	INTERNAL USE	Page 20 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland



6. References

Document	Version	Date
Project Scope Report	Rev 2	24/06/2025

Current version: 7/04/2025	INTERNAL USE	Page 21 of 21
Next revision due: 7/04/2030	HARDCOPY IS UNCONTROLLED	© Powerlink Queensland



Risk Cost Summary Report

CP.02498

Chalumbin 275kV Substation Reinvestment

Document Control

Change Record

Issue Date	Revision	Prepared by
19/01/2026	1.0	Asset Strategies

Related Documents

Issue Date	Responsible Person	Objective Document Name

Document Purpose

The purpose of this model is to quantify the base case and option risk cost profiles for equipment at the Chalumbin 275kV Substation which are proposed for reinvestment under CP.02498. 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.

Primary plant and Secondary systems have been assessed via independent models; however, their overall risk costs have been summed to produce a single analysis for the project.

Key Assumptions

In calculating the risk cost arising from a failure of the ageing equipment at Chalumbin 275kV Substation, the following modelling assumptions have been made:

Primary Plant

- The functionality of the equipment is assumed to decay according to decay curves calculated by Powerlink, and associated probability of failure (PoF).
- Where equipment in scope is replaced, its associated Health Index (HI) score is reverted to one. Where refurbishment is undertaken, the health index is adjusted according to the target life extension.
- The likelihood of personnel within the substation in the event of explosive failure of equipment (used to calculate safety risk) is assumed to be 25% (based upon historic site entry averages), with the likelihood of resulting injury or death depending on the explosive radius of the equipment, its housing, and the total substation land area. The modelling also assumes that personnel are equally likely to be anywhere within the substation land area. No escalation to the likelihood has been made during construction as it is assumed appropriate risk assessments and risk mitigation measures are completed by the project team.
- 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 for primary equipment (high voltage) plant and 20 years for secondary systems equipment.
- A site-specific value of customer reliability (VCR) of \$25,750 has been applied when calculating network risks.

Secondary Systems

- Whilst the re-investment scope of secondary systems contains a range of supporting devices (i.e monitoring equipment, marshallion kiosks, firewalls and human machine interfaces), for simplicity of risk cost modelling only main protection relays, bay controllers and RTUs/control racks were considered.

- Spares for secondary system equipment have been assumed to be available prior to the point of expected spares depletion, which coincides with the expected technical asset life (20 years). After this point the cost and time to return the secondary system back to service increases significantly.
- Given secondary systems have a shorter asset life, risk cost benefits have been modelled out to 2045, whereas substations assets have been modelled to 2060. This is providing a conservative view of the secondary systems benefits.

Base Case Risk Analysis

Risk Categories

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

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

Table 1: Risk categories

Risk Category	Failure Types	Equipment in scope
Substations Equipment		
Safety Risk	Explosive failure	All equipment with the potential to fail explosively based on Powerlink's experience
Financial Risk	Peaceful failure	All equipment
	Explosive failure	All equipment with the potential to fail explosively based on Powerlink's experience
Network Risk	Peaceful failure	All equipment related to network elements identified in the planning statement
Environmental Risk	Peaceful failure	Circuit breakers and current transformers containing SF6 gas
Secondary Systems		
Financial Risk	Failure of the equipment resulting in emergency onsite replacement	All equipment
Network Risk	Failure of equipment resulting in de-energisation of network elements after 24 hours	Main protection relays only

Base Case Risk Cost

The modelled and extrapolated total base case risk costs are shown in the figures below.

Risk cost associated with the equipment in scope is expected to increase from around \$0.62 million in 2026 to \$1.78 million in 2036 and \$3.21 million by 2045. Key highlights of the analysis include:

- Financial risk is 85% of the total risk (at 2030), reflecting the cost of replacement mainly due to the peaceful failures across both the primary and secondary systems assets.
- Network risk accounts for approximately 7% of the total risk cost in 2030.
- Safety risk accounts for 8% of the total risk (at 2030), reflecting a conservative assumption that personnel are unlikely to be in proximity of equipment during an explosive failure event.

A dip in risk cost can be observed in 2046 as the benefits associated with secondary systems assets roll off as highlighted in the assumptions listed above.



Figure 1: Total risk cost

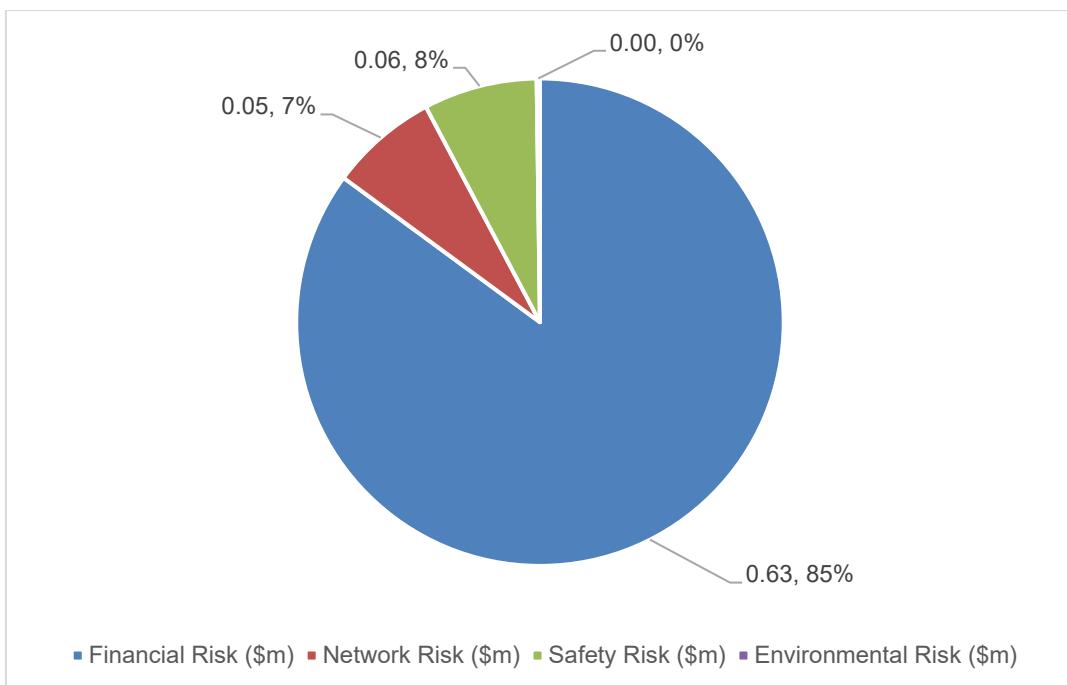


Figure 2: Base case risk cost by contributions (2030)

Option Risk Cost

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

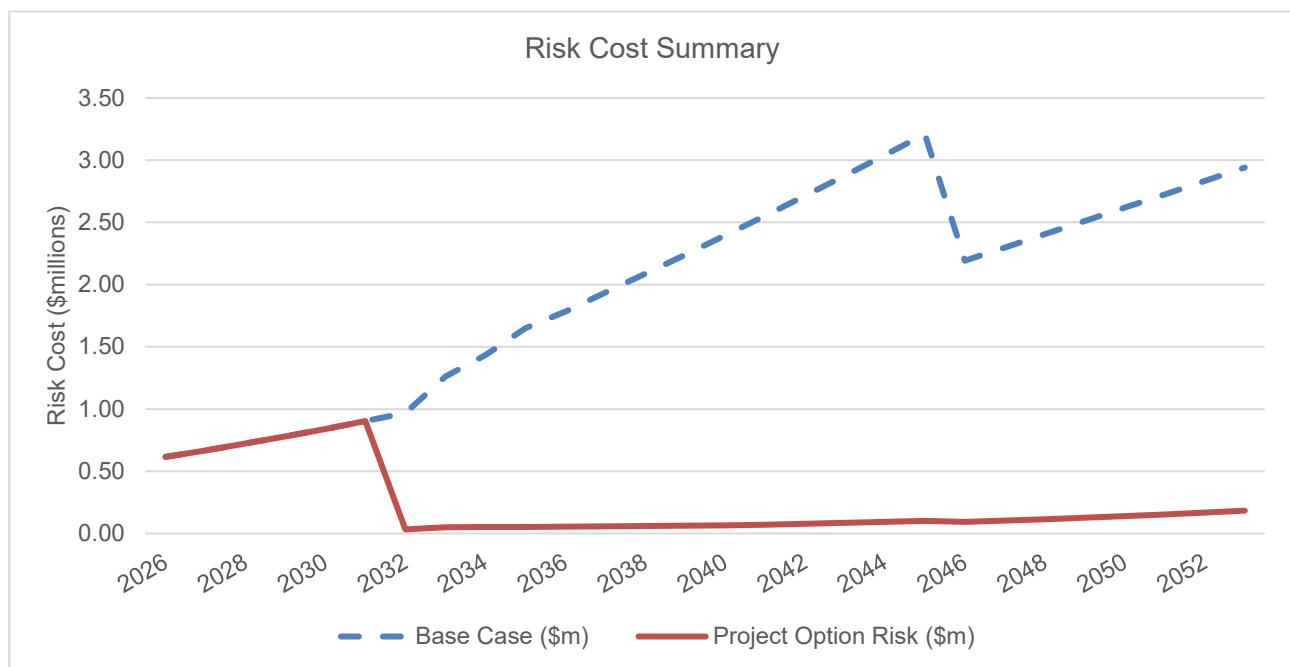


Figure 3: Project Option Risk Cost (compared to base case)

Following the year of investment (2031) the risk cost associated with the equipment in scope effectively reduces to approximately \$0.03m. By 2045, the risk cost of the project option is approximately \$0.1 million, compared with the base case risk cost of \$3.21 million.

Cost Benefit Analysis

The methodology designed for this regulatory review is set out below.

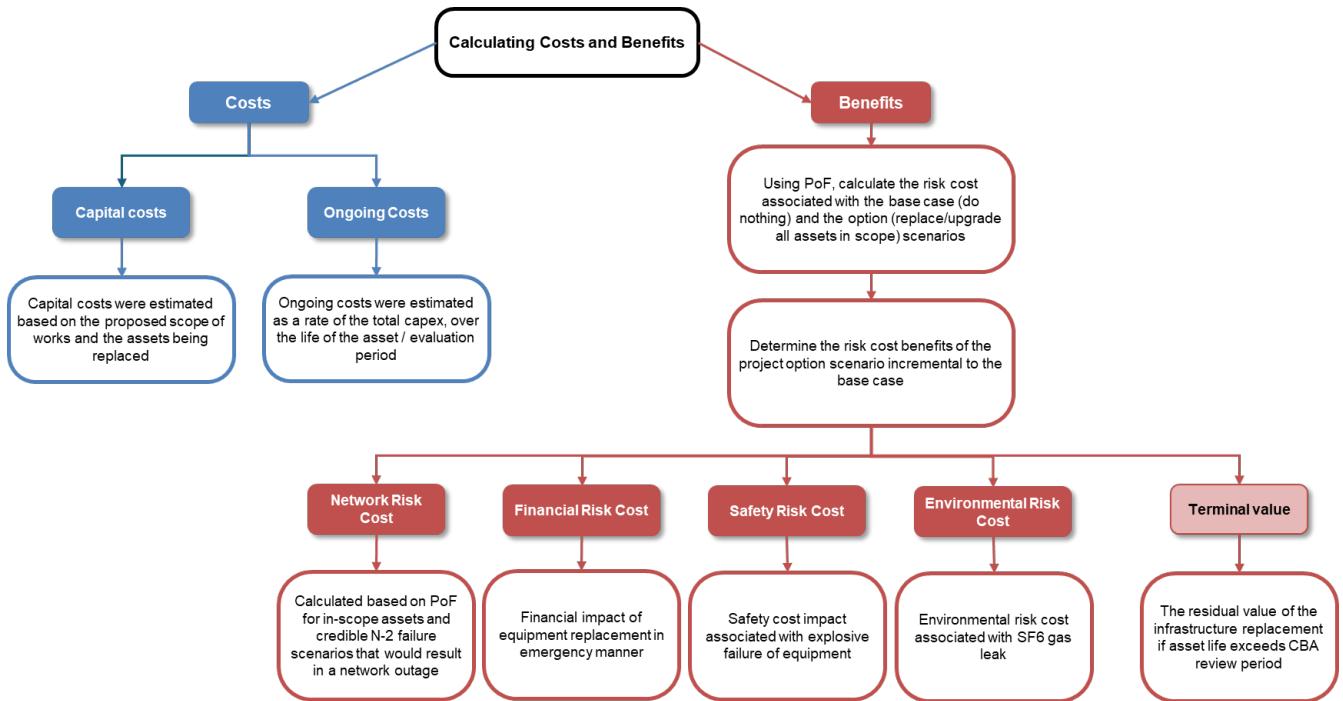


Figure 4: CBA methodology

The project is estimated to cost approximately \$29.87 million.

Based on a baseline discount factor of 7%, the project has a net present value (NPV) of -\$1.8 million over a 35-year period, and a benefit-cost ratio (BCR) of 0.91.

Table 2: Net Present Value and Benefit-Cost Ratio

		Present Value Table (\$m)		
Discount rate	%	3%	7%	10%
NPV of Net Gain/Loss	\$m	\$14.8	-\$1.8	-\$6.0
Benefit-Cost Ratio	ratio	1.59	0.91	0.65

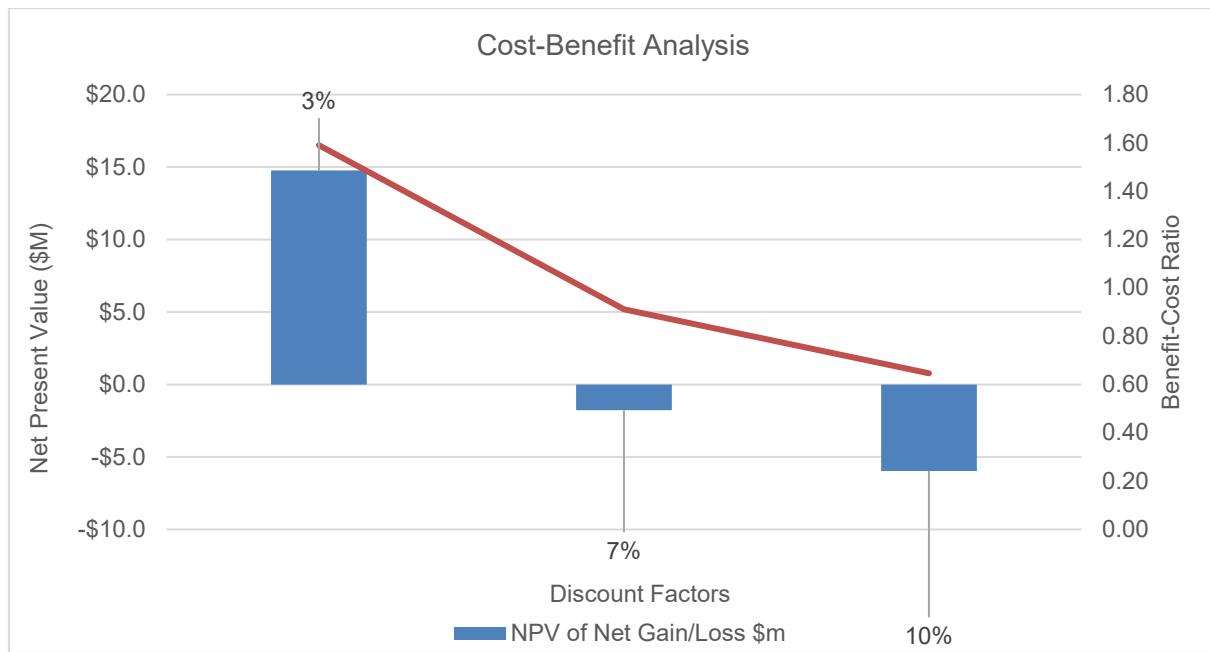


Figure 5: Cost benefit summary

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).

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 restoration time result** in a decrease in risk cost of \$0.02 million, or approximately 2.51 % of the original base risk (when individually halved).
- **changes in value of customer reliability result** in a decrease in risk cost of \$0.03 million, or approximately 3.23% of the original base risk (when individually halved).
- **changes in emergency premium of explosive failure** results in a decrease in risk cost of \$0.04 million or 4.08% of the original base risk (when halved)
- **changes in emergency premium of peaceful failure** results in a decrease in risk cost of \$0.05 million or 5.4% of the original base risk (when halved).

Table 3: Participation Factors

Input	Baseline value	Sensitivity value (-50%)	Change in risk cost at 2031 (\$m)	CBA	Participation (%)
Safety					
Likelihood of personnel within substation	25%	12.5%	-0.03	0.88	-3.75%
Cost consequence of multiple fatality	\$11,400,000	\$5,700,000	-0.01	0.90	-1.03%
Cost consequence of single fatality	\$5,700,000	\$2,850,000	-0.01	0.90	-0.96%
Cost consequence of multiple serious injury	\$4,206,600	\$2,103,300	-0.01	0.90	-0.73%
Financial					
Emergency premium (peaceful failure)	20%	10%	-0.05	0.87	-5.37%
Emergency premium (explosive failure of CTs only)	300%	150%	-0.04	0.87	-4.08%
Emergency replacement cost without spares – Relay (\$m)	0.09	0.05	0.00	0.79	-0.25%
Emergency replacement cost without spares – Bay Controller (\$m)	0.20	0.10	-0.04	0.78	-4.64%
Network					
VCR (\$/MWh)	25,750	12,875	-0.03	0.77	-3.23%
Restoration Time (hrs)	72-168 (subs)	36-84	-0.02	0.79	-2.51%