2023-27
POWERLINK QUEENSLAND REVENUE PROPOSAL

Project Pack – PUBLIC

CP.02760
Middle Ridge Secondary Systems Replacement

CP.02760 – Middle Ridge Secondary Systems Replacement

Project Status: Not Approved

1. Network Requirement

The Middle Ridge 330/275/110kV Substation, approx. 130km west of Brisbane, was established in 1965 and is an essential bulk supply point for local and South East Queensland including Toowoomba and the Darling Downs area. It is also a major transmission node between South West and South East Queensland. An outage of this asset would leave up to 650MW and up to 10,000MWh of customer load per day at risk across all feeders[2].

A Condition Assessment (CA) carried out in March 2019 identified that most secondary system assets will reach the end of their technical service lives by 2025[1]. The equipment is, or is becoming, obsolete with no support from the manufacturer and limited spares available. Beyond their 20 year nominal service life, secondary systems suffer increased failure rates. Increasing failure rates, along with the increased time to rectify the faults due to equipment obsolescence, significantly affects the availability and reliability of these systems. There is therefore a need for Powerlink to address this emerging risk to ensure ongoing compliance with Schedule 5.1.9(c) of the National Electricity Rules (NER) and AEMO's Power System Security Guidelines (V95, 2019).

Energy Queensland forecasts confirm there is an enduring need to maintain electricity supply into the Toowoomba and Darling Downs area. The removal or reconfiguration of the Middle Ridge Substation due to secondary system failure or obsolescence would violate Powerlink's Transmission Authority reliability obligations (N-1-50MW / maximum 600MWh unserved energy) and would significantly impact the power transfer capability to the Tarong grid section.

2. Recommended Option

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

The current recommended option is to replacement of all 330kV, 275kV and 110kV secondary systems at Middle Ridge Substation by end of 2025[2].

The following options were considered but not proposed:

- Do Nothing – rejected due to non-compliance with reliability standards.
- Non-Network Option parameters identified – at this stage no viable non-network option has been identified.

Figure 2-1 shows the current recommended option reduces the forecast risk monetisation profile of the Middle Ridge Substation secondary systems by over $600k per annum from 2027. The recommended option will extend the asset life by 20 years.

Where a 'Do Nothing' scenario is adopted, the forecast level of risk associated with the asset will reach over $600k per annum in 2026 and continue to rise each year thereafter. The risks for the secondary systems at Middle Ridge Substation are associated with financial risks to replace the failed secondary systems in an unplanned (emergency) manner, and network risks (unserved energy) resulting from concurrent network outages associated with equipment failures.[3]

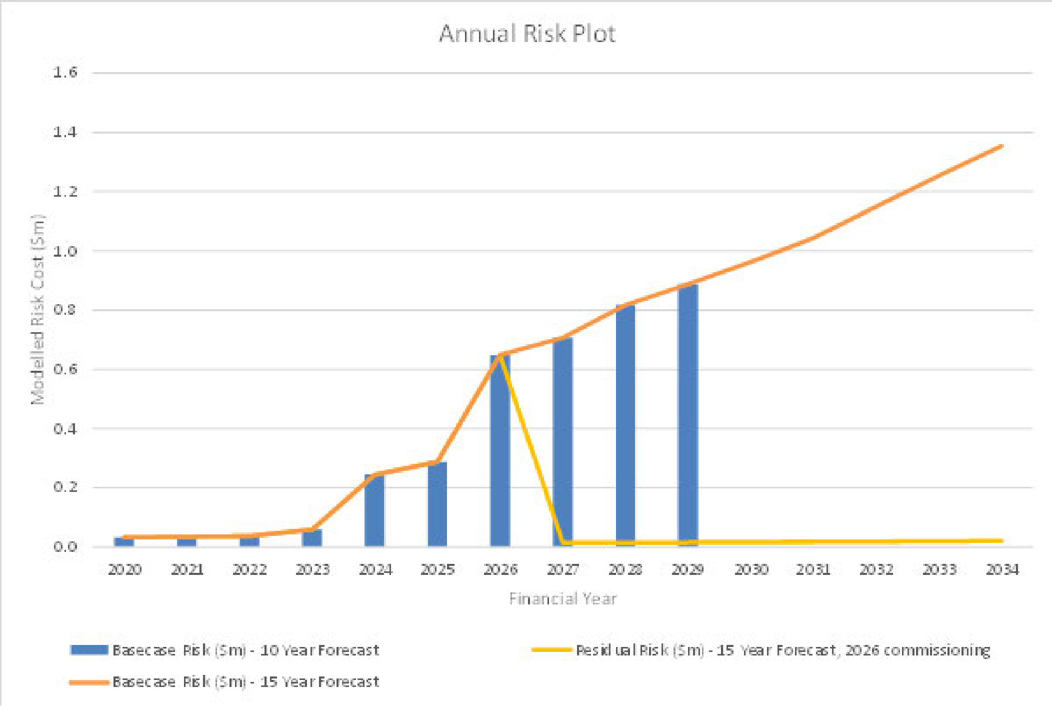

Figure 2-1 Annual Risk Monetisation Profile (Nominal)

3. Cost and Timing

The estimated cost to replace the secondary systems at Middle Ridge Substation is $30.5m ($2019/20 Base)[5].

Target Commissioning Date: October 2029[4]

Note: *Target commissioning date outlined in the CA has been extended to accommodate staging for the large number of outages required to cut in the new secondary systems. This will be reviewed during detailed planning and necessary mitigation plans will be established to address potential risks arising from the delayed removal of ageing secondary systems.*

4. Documents in CP.02760 Project Pack

Public Documents

1. Secondary Systems Condition Assessment Report – H014 Middle Ridge 330/275/110kV
2. CP.02760 – H014 Middle Ridge Secondary Systems Replacement – Planning Statement
3. Base Case Risk Summary Report CP.02760 Middle Ridge Secondary Systems Replacement
4. Project Scope Report CP.02760 Middle Ridge Secondary Systems Replacement
5. Concept Estimate for CP.02760 – Middle Ridge Secondary Systems Replacement

Supporting Documents

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

H014 Middle Ridge 330/275/110kV

Secondary Systems Condition Assessment Report

Document Details			
Version Number	2.0	**Principal Author**	[redacted]
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Issue Date	28/03/2019	**Authorised by**	[redacted]
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Date	Version	Nature of Change	Author	Authorisation
15/06/2018	1.0	New document	[redacted]	[redacted]
28/03/2019	2.0	Update health index	[redacted]	[redacted]

Table of Contents

1. Introduction

This report is pertinent to H014 Middle Ridge substation 330/275/110kV 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 Middle Ridge 330/275kV/110kV secondary systems.

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.

H014 Middle Ridge substation is a 330/275/110kV transmission substation located at the southern Queensland transmission network and is a key switch point to Southern Queensland. The 330/275/110kV yard is a major node in the wider interconnected network supplying power to Southern Queensland. Majority of secondary systems were commissioned from 2002 to 2007 while secondary systems in 2011 for 330kV 3 & 4 Cap.

[redacted]

H014 Middle Ridge operating diagram

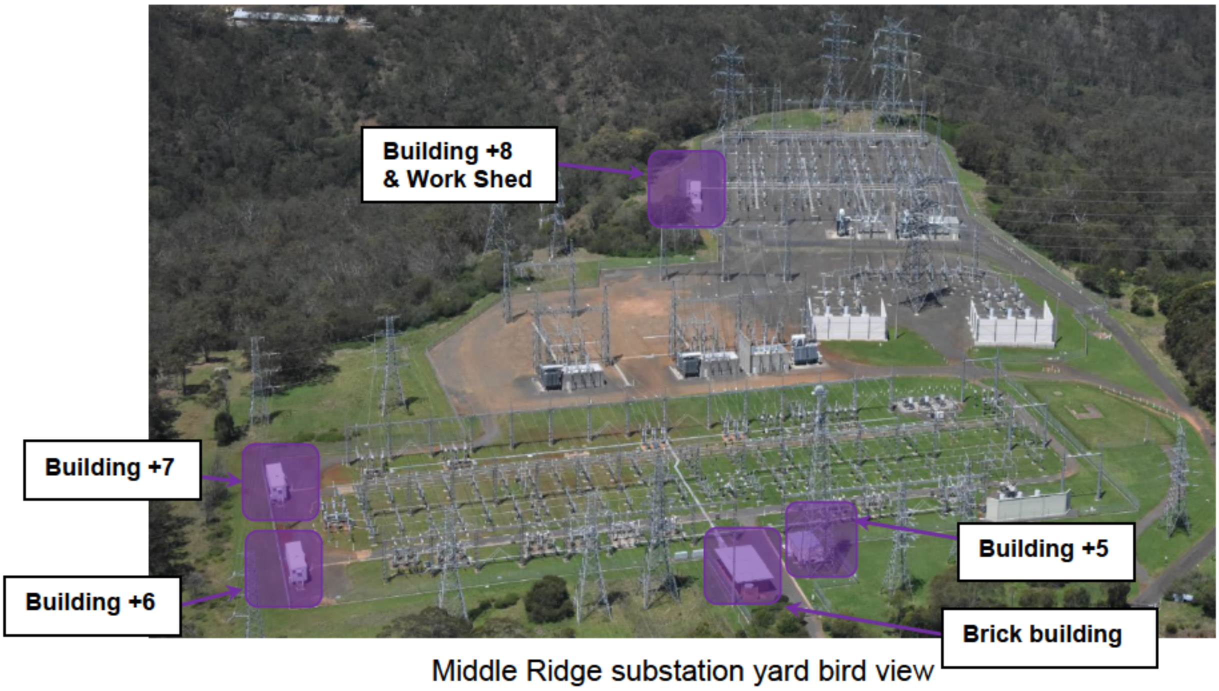
2. Site infrastructure

Middle Ridge substation consists of one yard of 330kV, 275kV and 110kV operating voltage enclosed by the one perimeter fence. The substation was built in 1965. Extensions with load growth have resulted in a mixture of secondary systems from 2002 through to 2011.

H014 Middle Ridge Substation is an essential transmission yard, with secondary systems for:-

- 2 x 330kV feeder bays
- 2 x 330kV Capacitor banks
- 275kV 1 and 2 Bus
- 275kV 1, 2, 3 and 4 coupler
- 5 x 275kV Transformer bays
- 3 x 275kV Feeders
- 3 x 110kV bus zones
- 3 x 110kV bus couplers
- 3 x 110kV Transformer bays
- 13 x 110kV feeder bays
- 2 x 110kV relocatable Capacitor banks

2 x 330kV feeder bays are energised through R004 Millmerran. 10 x 110kV feeder bays are connected to Ergon supplies such as Torrington, Yarranlea, Warwick, Toowoomba South and Kearneys Spring.



Middle Ridge substation yard bird view

The existing Middle Ridge substation site is located at Toowoomba area. Emergency and routine maintenance of the secondary systems is conducted by Powerlink staff at Virginia. The secondary system is housed in a Switchyard Services Building (SSB) and demountable buildings 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 in assessing 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.

4. Condition Assessment

4.1 Buildings

The condition assessment of buildings is a separate assessment and is carried out by Substation Strategies. The following details are for information only.

There are multiple buildings at H014 Middle Ridge, including:-

- Brick building
- COMMS building +5
- 110kV control building +6 and +7
- 330/330kV control building +8
- Work shed

The brick building was built in 1965. It is the main entry of the substation and contains intruder and fire protection system.

Brick building

Telecommunication building +5 was built in 2012. It is air-conditioned and contains telecommunication equipment including MPLS and MUX equipment.

COMMS building +5

Demountable building +6 and +7 were built in 2005. These building were air-conditioned and house all 110kV secondary systems and associated communication equipment. There are 6 x spare panel spaces in building +6 and 10 spares panel spaces in building +7 which can be used for future secondary system replacement or refurbishment.

Demountable control building +6 and +7

Demountable control building +8 was established in 2005. It is air-conditioned and accommodates all 330/275kV secondary systems. There are 4 x spare panel spaces in +8 which can be used for future secondary system replacement or refurbishment.

Demountable control building +8

4.2 Trench, marshalling cubicles and control cables

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

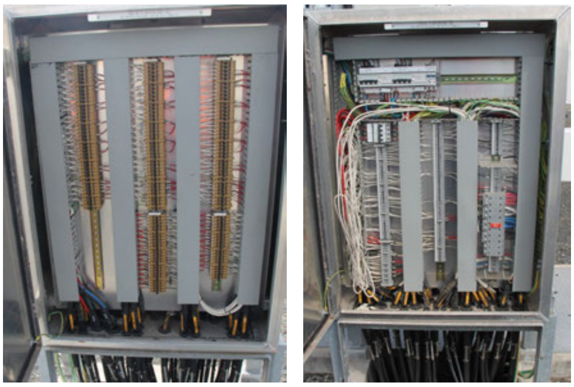
Typical substation trenches

4.2.1 330/275kV yard

VT boxes for Feeder 9907 and 9908 were installed in 2005 and 2007 respectively. These boxes are in fair condition. There are no condition-driven replacement required until 2040 and 2042 respectively.

Bay marshalling kiosks for 330kV Capacitor bank 3 and 4 were installed in 2011. They are in fair condition. However, the physical disconnect terminals for CT circuits should be replaced to mitigate CT open circuit risks with major secondary system replacement (refer below for examples).

There are no condition driven replacement required for associated control cables until 2046.

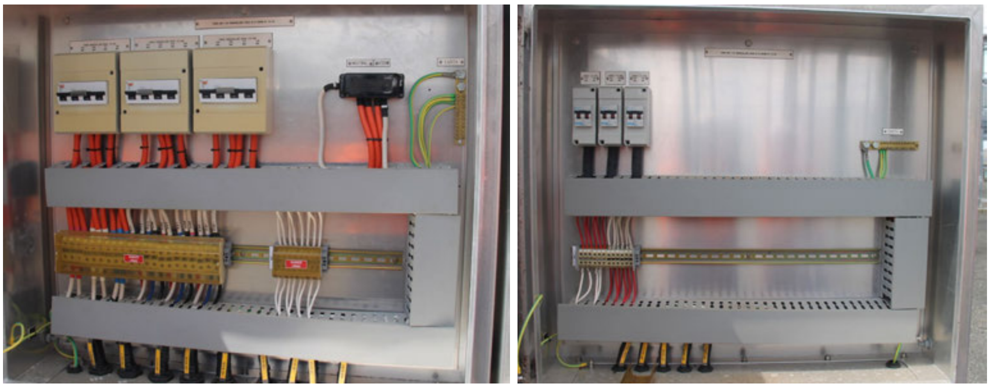


=B01 330kV Capacitor 3 bay marshalling kiosk

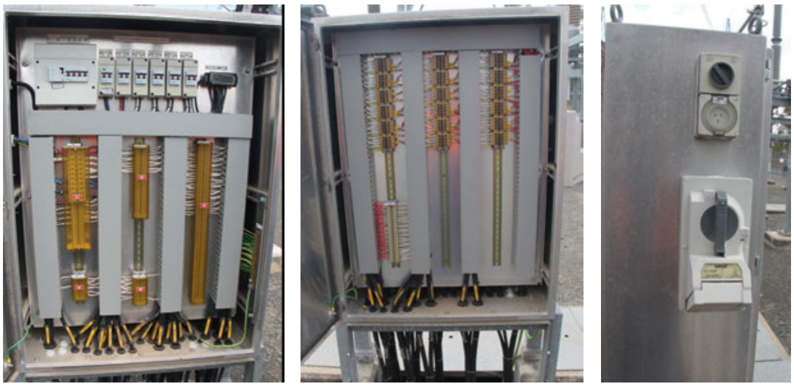
Bay marshalling kiosks, VT boxes and control cables for 275kV bus zones were installed in 2005. They are in fair condition. There are no condition-driven replacement required for VT boxes and control cables until 2040. However, the physical disconnect terminals for CT circuits for bay marshalling kiosks should be replaced to mitigate CT open circuit risks with major secondary system replacement (refer below for examples).

275kV 1 Bus marshalling kiosk and VT box

Bay marshalling kiosks, VT boxes, control cables and AC/DC marshalling for =C1 and =C2 were installed in 2005. There are no condition-driven replacement required until 2040. The physical disconnect terminals for CT circuits for all bay marshalling kiosks should be replaced to mitigate CT open circuit risks with major secondary system replacement (refer below for examples).



=C1 275kV AC and DC marshalling kiosk

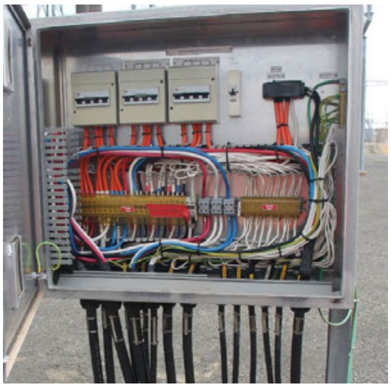


=C1 275kV coupler 501 marshalling kiosk

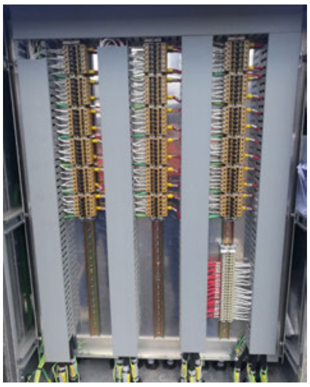
=C1 275kV Transformer 2 stub CVT box

AC supply termination cubicle

Bay marshalling kiosks and associated control cables for =C3 including AC/DC marshalling kiosk were installed in 2005. They are in fair condition. There are no condition driven replacement required for AC/DC marshalling kiosks, VT boxes and associated control cables until 2040. However, the physical disconnect terminals for CT circuits for bay marshalling kiosks should be replaced to mitigate CT open circuit risks with major secondary system replacement (refer below for examples).

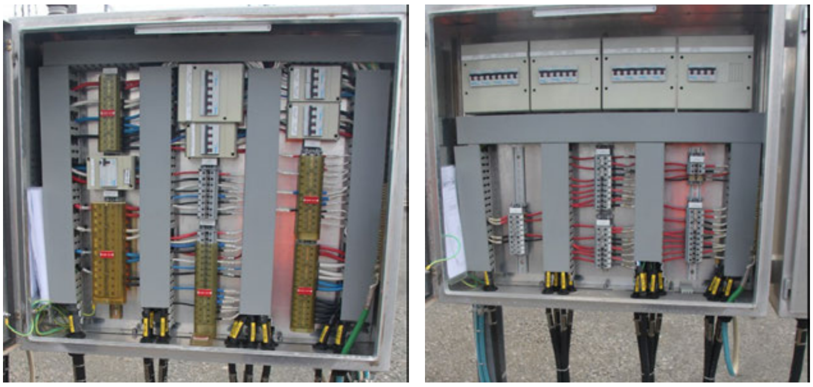


=C3 275kV AC and DC marshalling kiosk



=C3.1 Feeder 8848 CB marshalling kiosk and CVT box

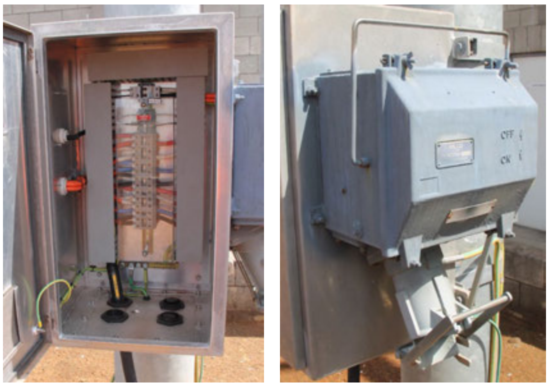
Marshalling kiosks and associated cables for =C4 were installed in 2007. They are in good condition. There are no condition driven replacement required for AC/DC marshalling kiosks and associated control cables until 2042. However, the physical disconnect terminals for CT circuits for bay marshalling kiosks should be replaced to mitigate CT open circuit risks with major secondary system replacement (refer below for examples).



=C4 275kV AC and DC marshalling kiosk

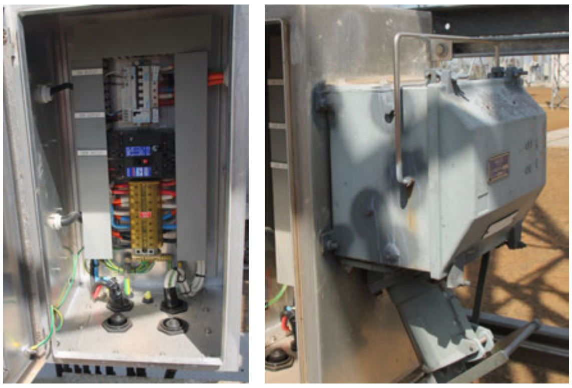
=C4 275kV 5 transformer CB marshalling kiosk and VT box

Transformer 1 and 4 power outlet box were installed in 2005 and are in fair condition. There are no condition driven replacement required until 2040 (refer below for examples).



Transformer 1 power outlet box

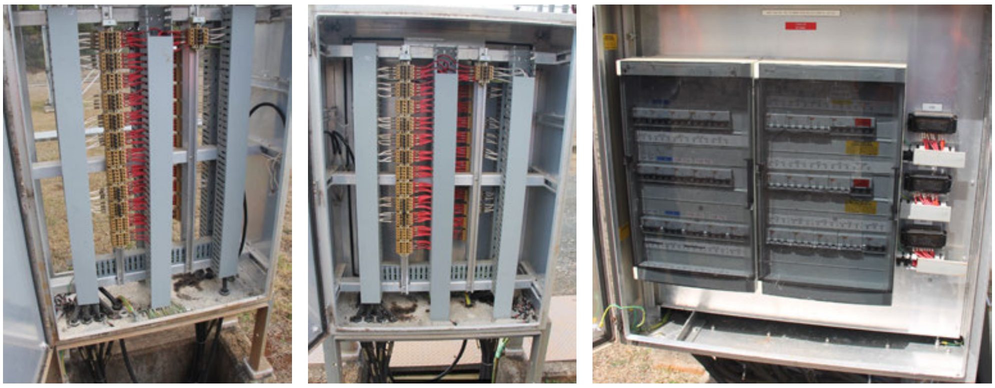
Transformer 2 and 3 power outlet box were installed in 2005 and are in fair condition. There are no condition driven replacement required until 2040.



Transformer 2 and 3 power outlet box

4.2.2 110kV yard

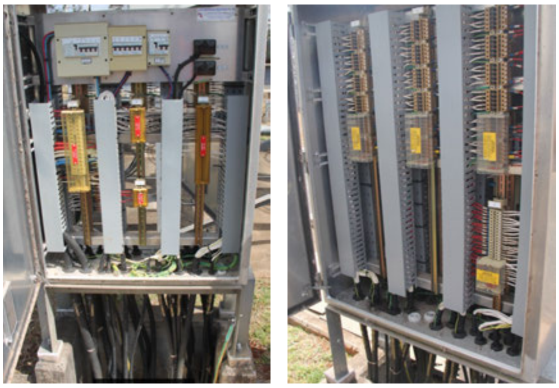
Bay marshalling kiosks, VT box and associated control cables for 110kV 1, 2, and 3 bus were installed in 2005. They are in fair condition. There are no condition driven replacement required for VT boxes and associated control cables until 2040. However, the physical disconnect terminals for CT circuits for bay marshalling kiosks should be replaced to mitigate CT open circuit risks with major secondary system replacement (refer below for examples).



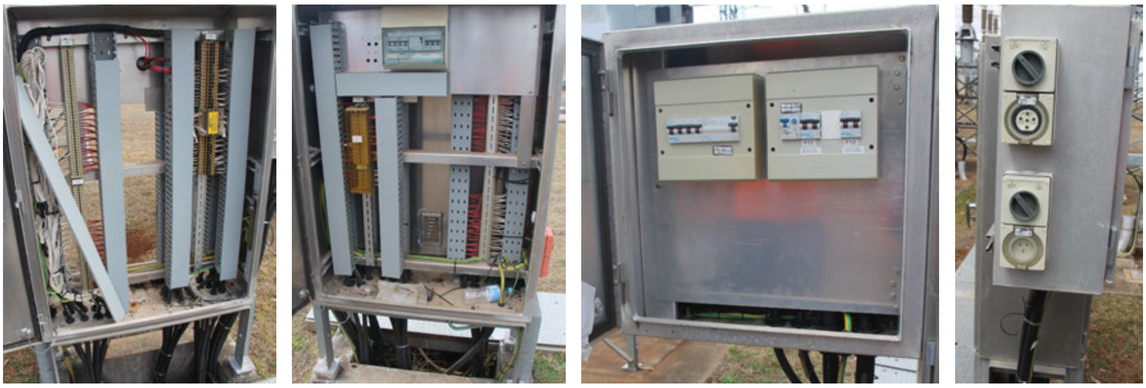
110kV 2 Bus – Bus zone marshalling kiosk and VT box

110kV bus coupler 1-2, 2-3 and 1-3 were installed (including 415/240V AC supply marshalling kiosk) in 2005 and are in fair condition. There are no condition driven replacement required for AC supply kiosk and associated control cables until 2040. However, the physical disconnect terminals for CT circuits for bay marshalling kiosks should be replaced to mitigate CT open circuit risks with major secondary system replacement (refer below for examples).

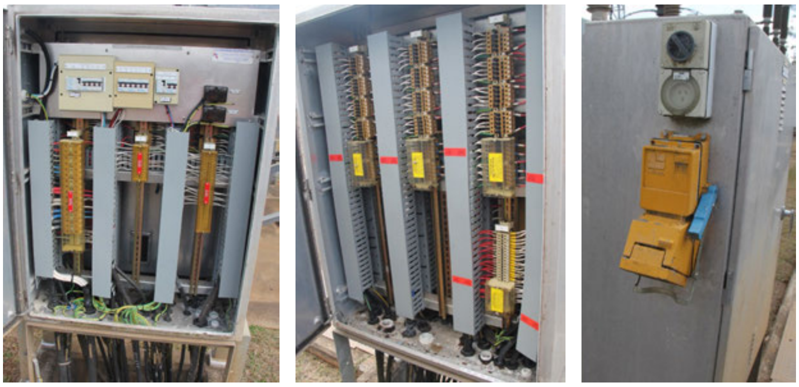

=D0.0 Bus 2-3 coupler marshalling kiosk


415/240V AC supply marshalling kiosk

Marshalling kiosks and associated control cables for =D1 Feeder 728 and 730 were installed between 2003 and 2004. They are in fair condition. As such there are no condition driven replacements required for control cables until 2038-2039. However, the physical disconnect terminals for CT circuits for bay marshalling kiosks should be replaced to mitigate CT open circuit risks with major secondary system replacement (refer below for examples).


=D1.2 Feeder 728 marshalling kiosk

Marshalling kiosks and associated control cables for Feeder 7233, 727, 7234 and 732 were installed between 2004 and 2005. The kiosk structure appears sound with wirings intact. There are no condition-driven replacement required for control cables until 2039-2044. However, the physical disconnect terminals for CT circuits for bay marshalling kiosks should be replaced to mitigate CT open circuit risks with major secondary system replacement (refer below for examples).

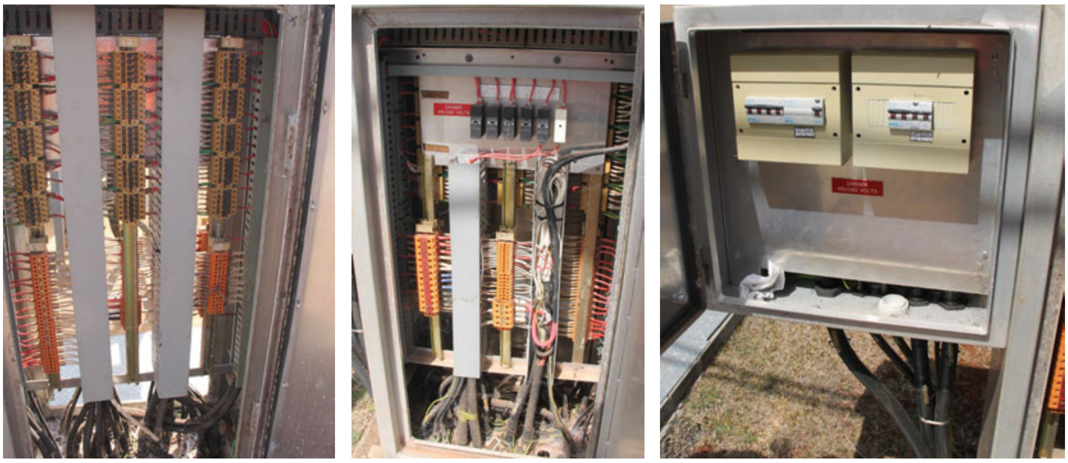


=D2.3 Feeder 7233 marshalling kiosk

Marshalling kiosk and associated control cables for Feeder 731 were installed in 1999. There are no condition driven replacement required for control cables until 2034-2039. However, the physical disconnect terminals for CT circuits for all bay marshalling kiosks should be replaced to mitigate CT open circuit risks with major secondary system replacement.

=D6 Feeder 731 marshalling kiosk

Marshalling kiosks and associated control cables for 2 and 3 transformer 110kV side were installed in 1987. Orange coloured Utilux terminals in the marshalling kiosk are showing signs of embrittlement. Fuses are utilised within these marshalling kiosks. These 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. Bay marshalling kiosks and associated cables should be replaced with major secondary system or primary plant replacement between 2022 and 2027.



=D8 110kV Transformer 3 marshalling kiosk

Marshalling kiosks and associated control cables for Feeder 733, 110kV 1 Transformer, Feeder 736, Feeder 7348, spare 5 bay and Feeder 735 were installed between 2004 and 2005 (Except Feeder 7348 in 2011). These are in fair condition and there are no condition driven replacement required for control cables until 2039-2044. However, the physical disconnect terminals for CT circuits for bay marshalling kiosks should be replaced to mitigate CT open circuit risks with major secondary system replacement (refer below for examples).

=D11.1 Feeder 733 marshalling kiosk

4.3 Control and protection bays

4.3.1 Protection and control panels

Secondary systems at Middle Ridge 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.

4.3.2 330kV feeder bay secondary systems

Equipment details of 330kV feeder bay secondary systems are listed in a table below:-

330kV Feeder Bays	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
Feeder 9907	X	P544	2007	No	Yes	Yes	5.90
		9745 Digital	2007	Yes	Yes	Yes	5.90
		D1200 Digital	2007	Yes	Yes	Yes	5.90
	Y	SEL-421	2007	Yes	Yes	Yes	5.90
		DM1200 Digital	2007	No	Yes	Yes	5.90
	Control	C50	2007	No	No	Yes	5.90
Feeder 9908	X	P544	2004	No	Yes	Yes	7.20
		P591	2005	No	Yes	Yes	7.00
		DM1200 Digital	2005	No	Yes	Yes	7.00
		9745 digital	2005	Yes	Yes	Yes	7.00
	Y	SEL-421	2005	Yes	Yes	Yes	7.00
		DM1200 Digital	2005	No	Yes	Yes	7.00
	Control	C50	2005	No	No	Yes	7.00

***PLQ Spares**: Limited – Spares will be depleted within 5 years
Yes – The estimated time of depletion is more than 5 years

330kV feeders 9907 and 9908 are protected by digital current differential relays P544 and distance protection relays SEL-421. The health index indicates that majority of secondary systems for Feeder 9907 and 9908 will reach the end of technical life and should be replaced by 2027 and 2025 respectively.

330kV =B02 Feeder 9907 and =B01 Feeder 9908 protection and control panel

4.3.3 330kV Capacitor Bays

Secondary systems for 330kV Capacitor bank bays are detailed in a table below.

330kV Cap	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
3 CAP	X	MFAC34	2011	Yes	Yes	Yes	3.80
		SPAJ160C	2011	Yes	Yes	Yes	3.80
		C60	2011	Yes	Yes	Yes	4.00
	Y	SEL-451-1	2011	Yes	Yes	Yes	3.80
		SPAJ160C	2011	Yes	Yes	Yes	3.80
	POW	F236	2011	Yes	Yes	Yes	7.30
	Local RTU	C50	2011	No	No	Yes	4.16
4 CAP	X	MFAC34	2011	Yes	Yes	Yes	3.70
		SPAJ160C	2011	Yes	Yes	Yes	3.70
		C60	2011	Yes	Yes	Yes	4.00
	Y	SEL-451-1	2011	Yes	Yes	Yes	3.70
		SPAJ160C	2011	Yes	Yes	Yes	3.70
	POW	F236	2011	Yes	Yes	Yes	7.30
	Local RTU	C50	2011	No	No	Yes	4.16

*PLQ Spares: Limited – Spares will be depleted within 5 years
Yes – The estimated time of depletion is more than 5 years

High Impedance MFAC34 and Balance protection SPAJ160C are used to protect 3 and 4 capacitor banks. These relays were installed in 2011 and have been providing reliable services. The health index shows that there are no condition driven replacement required until 2031-2032.

C50 RTUs are utilized for the function of control. These C50 RTUs have become obsolete. Powerlink had the last buy of C50s in 2014 and has relied on these spares to maintian their operation.

330kV 3 & 4 CAP protection and control panel

4.3.4 275kV bus zone and coupler bay

Secondary systems for 275kV bus zones and coupler bays are shown in table below:-

Bus	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	HI Health Index
1 Bus	X	MFAC34	2005	Yes	Yes	Yes	7.00
		MVAJ13	2005	Yes	Yes	Yes	7.00
		MVAX12	2005	Yes	Yes	Yes	7.00
		CB Fail Trip rack	2005	Yes	Yes	Yes	7.00
	Y	MFAC34	2005	Yes	Yes	Yes	7.00
		MVAJ13	2005	Yes	Yes	Yes	7.00
		MVAX12	2005	Yes	Yes	Yes	7.00
	Local control	C50	2005	No	No	Yes	7.00
2 Bus	X	MFAC34	2005	Yes	Yes	Yes	7.00
		MVAJ13	2005	Yes	Yes	Yes	7.00
		MVAX12	2005	Yes	Yes	Yes	7.00
	Y	MFAC34	2005	Yes	Yes	Yes	7.00
		MVAJ13	2005	Yes	Yes	Yes	7.00
		MVAX12	2005	Yes	Yes	Yes	7.00
	Local control	C50	2005	No	No	Yes	7.00
Coupler 501	X	C60	2005	Yes	Yes	Yes	7.00
	Y	SEL-352	2005	Yes	Yes	Yes	7.00
	Local control	C50	2005	No	No	Yes	7.00
Coupler 502	X		2005	Yes	Yes	Yes	7.00
	Y		2005	Yes	Yes	Yes	7.00
	Local control	C50	2005	No	No	Yes	7.00
Coupler 503	X		2005	Yes	Yes	Yes	7.00
	Y		2005	Yes	Yes	Yes	7.00
	Local control	C50	2005	No	No	Yes	7.00
Coupler 504	X	C60	2007	Yes	Yes	Yes	5.90
	Y	SEL-451	2007	Yes	Yes	Yes	5.90
	Local control	C50	2007	No	No	Yes	5.90

*__PLQ Spares__: Limited – Spares will be depleted within 5 years
Yes – The estimated time of depletion is more than 5 years

275kV Bus zone protections were commissioned in 2005. Associated health index indicate that secondary systems for 1 & 2 275kV bus zones will reach the end of technical asset life and should be replaced between 2025 and 2026.

275kV 1 & 2 Bus zone and CB fail panels

Secondary systems for coupler 501, 502 and 503 and 504 were installed in 2005. Health index calculated based on the reliability analysis shows that all these secondary systems should be replaced between 2025 and 2026. Secondary systems for coupler 504 were installed in 2007. Health index calculated based on the reliability analysis shows that all these secondary systems should be replaced between 2027 and 2028 (refer below for examples).

275kV bus coupler 501 and 504 protection and control panel

4.3.5 330/275kV transformer bays

As both Feeder 9907 and 9908 are transformer ended feeder without 330kV CB for 4T and 5T, all secondary systems for 4T and 5T have been implemented and allocated at 275kV side.

Equipment for 330/275kV transformer bays is detailed below.

Transformer	Relay & control		Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
4T	275kV	X	MFAC14	2005	Yes	Yes	Yes	7.00
			T60	2005	No	Yes	Yes	7.00
			F35	2005	No	Yes	Yes	7.00
		Y	SEL-387-5	2005	Yes	Yes	Yes	7.00
		Local RTU	C50	2005	No	No	Yes	7.00
5T	275kV	X	MFAC14	2007	Yes	Yes	Yes	5.90
			T60	2007	No	Yes	Yes	5.90
			F35	2007	No	Yes	Yes	5.90
		Y	SEL-387-5	2007	Yes	Yes	Yes	5.90
		Local RTU	C50	2008	No	No	Yes	5.20
*PLQ Spares: Limited – Spares will be depleted within 5 years Yes – The estimated time of depletion is more than 5 years								

Secondary systems for 4T and 5T were installed in 2005 and 2007/2008 respectively. The health index indicates these relays will reach the end of technical life and should be replaced by 2025 and 2027 respectively.

4 and 5 Transformer 275kV protection and control panel

4.3.6 275kV feeder bays

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

275kV Feeder	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
831	X	C60	2005	Yes	Yes	Yes	7.00
		P442	2009	No	Yes	Yes	4.90
		9745 digital	2005	Yes	Yes	Yes	7.00
		9745 digital	2005	Yes	Yes	Yes	6.90
	Y	SEL-421	2005	Yes	Yes	Yes	7.00
		DM1200 Digital	2009	No	Yes	Yes	4.90
	Prot Signalling	9745 digital	2005	Yes	Yes	Yes	6.90
		DM1200 Digital	2005	No	Yes	Yes	6.90
	Local RTU	C50	2005	No	No	Yes	7.00
8848	X	P544	2005	No	Yes	Yes	6.90
	Y	SEL-421	2007	Yes	Yes	Yes	5.90
		DM1200 Digital	2007	No	Yes	Yes	5.90
	Prot Signalling	9745 digital	2007	Yes	Yes	Yes	5.90
		DM1200 Digital	2007	No	Yes	Yes	5.90
	Local RTU	C50	2007	No	No	Yes	5.90
8849	X	P544	2018	No	Yes	Yes	4.10
		P591	2015	No	Yes	Yes	2.40
	Y	SEL-421	2012	Yes	Yes	Yes	4.40
		DM1200 Digital	2007	No	Yes	Yes	5.90
	Prot Signalling	9745 digital	2007	Yes	Yes	Yes	5.90
		DM1200 Digital	2007	No	Yes	Yes	5.90
	Local RTU	C50	2007	No	No	Yes	5.90

*__PLQ Spares__: Limited – Spares will be depleted within 5 years
Yes – The estimated time of depletion is more than 5 years

275kV feeders 831 is protected by duplicate distance protection P442 and SEL-421 with associated protection signalling devices. Majority of them were installed in 2005 (except DM1200 and P442 in 2009 which have become obsolete). The health index indicates that majority of equipment will reach the end of technical life and should be replaced by 2025.

Feeder 831 protection and control panel

Current differential and distance protection schemes with associated protection signalling equipment are utilized to protection Feeder 8848. Majority of secondary systems for Feeder 8848 were installed in 2007. The health index indicates that these secondary systems will reach the end of useful asset life and should be replaced by 2027.

Feeder 8848 protection and control panel

Feeder 8849 is protected by current differential and distance protection schemes with associated protection signalling devices. Associated protection relays were replaced between 2012 and 2018 while the bay control RTU and protection signalling equipment were replaced in 2007. The health index shows that there are no condition driven replacement required for protection relays until 2029 while the bay controller C50 and associated protection signalling should be replaced by 2027.

Feeder 8849 protection and control panel

4.3.7 275/110kV transformer bays

Secondary systems for 275/110kV transformer bays are detailed in a table below.

Transformer		Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
1 Transformer	275kV	X Protection	MFAC14	2005	Yes	Yes	Yes	7.00
			F35	2005	No	Yes	Yes	7.00
			T60	2005	No	Yes	Yes	7.00
		Y Protection	SEL-387	2005	Yes	Yes	Yes	7.00
		Bay Controller	C50	2005	No	No	Yes	7.00
	110kV	CB Fail X	C60	2005	Yes	Yes	Yes	7.00
		CB Fail Y	SEL-351-1	2005	Yes	Yes	Yes	7.00
		Bay control	C50	2005	No	No	Yes	7.00
2 Transformer	275kV	X Protection	T60	2005	No	Yes	Yes	7.00
			F35	2005	No	Yes	Yes	7.00
		Y Protection	SEL-387-5	2005	Yes	Yes	Yes	7.00
		Bay Controller	C50	2005	No	No	Yes	7.00
	110kV	CB Fail X	C60	2005	Yes	Yes	Yes	6.90
		CB Fail Y	SEL-351-1	2005	Yes	Yes	Yes	6.90
		Bay control	C50	2005	No	No	Yes	6.90
3 Transformer	275kV	X Protection	T60	2005	No	Yes	Yes	7.00
			F35	2005	No	Yes	Yes	7.00
		Y Protection	SEL-387-5	2005	Yes	Yes	Yes	7.00
		Bay Controller	C50	2005	No	No	Yes	7.00
	110kV	CB Fail X	C60	2005	Yes	Yes	Yes	6.90
		CB Fail Y	SEL-351-1	2005	Yes	Yes	Yes	6.90
		Bay control	C50	2005	No	No	Yes	6.90

*PLQ Spares: Limited – Spares will be depleted within 5 years
Yes – The estimated time of depletion is more than 5 years

High impedance REF relay MFAC14, biased current differential relay T60 and SEL-387-5 are utilized to protection transformer 1, 2 and 3. These secondary systems were installed in 2005 and have provided reliable services. Associated health index indicates that all secondary systems for 1T, 2T and 3T will reach the end of technical asset life and should be replaced by 2025.

2T protection and control panel

4.3.8 110kV Bus zones and coupler bays

Secondary systems for 110kV bus zones and coupler bays are listed in a table below.

110kV Bus	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
1 Bus	X	MFAC34	2005	Yes	Yes	Yes	7.00
		MVAX12	2005	Yes	Yes	Yes	7.00
		MVAJ13	2005	Yes	Yes	Yes	7.00
		CB Fail Trip Rack	2005	Yes	Yes	Yes	7.00
	Y	MFAC34	2005	Yes	Yes	Yes	7.00
		MVAX12	2005	Yes	Yes	Yes	7.00
		MVAJ13	2005	Yes	Yes	Yes	7.00
		CB Fail Trip Rack	2005	Yes	Yes	Yes	7.00
	Local Control	C50	2005	No	No	Yes	7.00
2 Bus	X	MFAC34	2005	Yes	Yes	Yes	7.00
		MVAX12	2005	Yes	Yes	Yes	7.00
		MVAJ13	2005	Yes	Yes	Yes	7.00
		CB Fail Trip Rack	2005	Yes	Yes	Yes	7.00
	Y	MFAC34	2005	Yes	Yes	Yes	7.00
		MVAX12	2005	Yes	Yes	Yes	7.00
		MVAJ13	2005	Yes	Yes	Yes	7.00
		CB Fail Trip Rack	2005	Yes	Yes	Yes	7.00
	Local Control	C50	2005	No	No	Yes	7.00
3 & 4 Bus	X	MFAC34	2005	Yes	Yes	Yes	7.00
		MVAX12	2005	Yes	Yes	Yes	7.00
		MVAJ13	2005	Yes	Yes	Yes	7.00
		CB Fail Trip Rack	2005	Yes	Yes	Yes	7.00
	Y	MFAC34	2005	Yes	Yes	Yes	7.00
		MVAX12	2005	Yes	Yes	Yes	7.00
		MVAJ13	2005	Yes	Yes	Yes	7.00
		CB Fail Trip Rack	2005	Yes	Yes	Yes	7.00
	Local Control	C50	2005	No	No	Yes	7.00
Coupler 401	CB Fail X	C60	2005	Yes	Yes	Yes	6.80
	CB Fail Y	SEL-351-1	2005	Yes	Yes	Yes	6.80
	Local Control	C50	2005	No	No	Yes	6.80
Coupler 402	CB Fail X	C60	2005	Yes	Yes	Yes	7.10
	CB Fail Y	SEL-351-1	2005	Yes	Yes	Yes	7.10
	Local Control	C50	2005	No	Yes	Yes	7.10
Coupler 411	CB Fail X	C60	2005	Yes	Yes	Yes	6.80
	CB Fail Y	SEL-351-1	2005	Yes	Yes	Yes	6.80
	Local Control	C50	2005	No	No	Yes	6.80

*PLQ Spares: Limited – Spares will be depleted within 5 years
Yes – The estimated time of depletion is more than 5 years

Duplicate high impedance differential relays MFAC34 are used to protect 110kV bus zones 1, 2 and 3 & 4. These relays were installed in 2005 and have provided reliable services. Health index shows that all secondary systems for 110kV bus zones will reach the end of technical asset life and should be replaced by 2025.

110kV Bus zone protection and control panels

C60, SEL-351 and C50 are utilized for 110kV coupler CB management. These protection and control devices were installed in 2005. Health index shows that all secondary systems for 110kV bus couplers will reach the end of technical asset life and should be replaced by 2025.

110kV bus coupler 401, 402 and 411 protection and control panel

4.3.9 110kV feeder bays

Secondary systems for 110kV feeder bays are detailed in a table below.

Feeder	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
711	X	L90	2005	No	Yes	Yes	6.80
	Y	SEL-311C	2005	Yes	Yes	Yes	6.80
		DM1200 Digital	2005	No	Yes	Yes	6.80
	Local RTU	C50	2005	No	No	Yes	6.80
7233	X	SEL-311C	2003	Yes	Yes	Yes	7.70
	Y	L90	2003	No	Yes	Yes	7.70
	PROT SIG	M695	2006	No	No	No	6.50
	Local RTU	C50	2009	No	No	Yes	5.10
7234	X	SEL-311C	2009	Yes	Yes	Yes	4.90
	Y	L90	2003	No	Yes	Yes	7.70
	Local RTU	C50	2008	No	No	Yes	5.30
727	X	L90	2005	No	Yes	Yes	6.80
	Y	SEL-311C	2005	Yes	Yes	Yes	6.80
	Local RTU	C50	2005	No	No	Yes	6.80
728	X	P546	2015	No	Yes	Yes	4.70
	Y	SEL-311L	2015	Yes	Yes	Yes	4.50
	PROT SIG	DM1200 VF	2002	No	Yes	Yes	8.70
	Local RTU	C50	2007	No	No	Yes	5.80
730	X	P546	2015	No	Yes	Yes	4.70
	Y	SEL-311L	2015	Yes	Yes	Yes	4.50
	PROT SIG	DM1200 VF	2002	No	Yes	Yes	8.40
	Local RTU	C50	2007	No	No	Yes	5.80
731	X	P442	2005	No	Yes	Yes	7.00
	Y	SEL-311C	2003	Yes	Yes	Yes	7.00
	PROT SIG	9745 Digital	2009	Yes	Yes	Yes	5.50
	Local RTU	C50	2009	No	No	Yes	5.10
732	X	P442	2006	No	Yes	Yes	6.30
	Y	SEL-311C	2003	Yes	Yes	Yes	7.70
	PROT SIG	9745 Digital	2009	Yes	Yes	Yes	5.90
	Local RTU	C50	2009	No	No	Yes	5.10
733	X	L90	2005	No	Yes	Yes	6.00
	Y	SEL-311C	2005	Yes	Yes	Yes	6.00
	Local RTU	C50	2005	No	No	Yes	6.00
734	X	L90	2007	No	Yes	Yes	5.70
	Y	SEL-311C	2007	Yes	Yes	Yes	5.70
	Local RTU	C50	2007	No	No	Yes	5.70
7348	X	P546	2011	No	Yes	Yes	5.20
		P591	2011	No	Yes	Yes	3.90
	Y	SEL-311C	2005	Yes	Yes	Yes	6.70
	Local RTU	C50	2005	No	No	Yes	6.70
735	X	P442	2005	No	Yes	Yes	6.70
	Y	SEL-311C	2005	Yes	Yes	Yes	6.70
	PROT SIG	DM1200 Digital	2005	No	Yes	Yes	6.70

Feeder	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
	Local RTU	C50	2005	No	No	Yes	6.70
736	X	P442	2007	No	Yes	Yes	5.80
	Y	SEL-311C	2007	Yes	Yes	Yes	5.70
	PROT SIG	DM1200 Digital	2002	No	Yes	Yes	8.20
	Local RTU	C50	2007	No	No	Yes	5.70
*PLQ Spares: Limited – Spares will be depleted within 5 years Yes – The estimated time of depletion is more than 5 years							

All protection and control panels for 110kV feeders were installed under CP.01068 Middle Ridge 110kV substation refurbishment between 2003 and 2005. This type of original SDM7 swing frame panel has isolation issues and potential termination falling loose risks. They should be updated to mitigate associated safety risks with major secondary system replacement.

Associated secondary systems were commissioned in different stages and some protection relays were replaced due to change of protection schemes in different projects:-

- Secondary systems for Feeder 728, 730, 734 and 736 were re-commissioned under OR.00945 in 2007
- Secondary systems for Feeder 7233, 7234, 731 and 732 re-commissioned under OR.01133 in 2008
- Protection relays for feeder 728 and 730 were replaced within the existing panel under OR.01708 in 2015.

Secondary systems for Feeder 734 and 736 were commissioned in 2007. Associated health index shows that these secondary systems will reach the end of useful asset life and should be replaced by 2027 (refer below for examples).

=D7.3 Feeder 734 protection and control panel

Majority of secondary systems for Feeders 7233 and 7234 were installed between 2003 and 2005. They are facilitated within swing frame panels and have been providing reliable operations. Health index shows that these secondary systems will reach the end of technical asset life and should be replaced by between 2023 and 2025 (refer below for examples).

=D2.3 Feeder 7233 protection and control panel

Secondary systems for Feeder 711, 727, 733, 735 were installed in 2005. Health index indicate that these secondary systems will reach the end of technical asset life and should be replaced by 2025.

=D14.3 Feeder 735 protection and control panel

Secondary systems for Feeder 731 and 732 were commissioned in 2008 while the panel were installed between 2003 and 2005. Considering the condition of panel and health index of secondary systems across the whole bay, secondary systems should be replaced by 2025.


=D5.2 Feeder 732 protection and control panel

X protection relay was replaced for Feeder 7348 under CP.01751 Middle Ridge - Murphys Creek 110kV Feeder in 2011 within the existing panel. Considering the overall condition of the bay, secondary systems should be replaced by 2025.


=D12.3 Feeder 7348 protection and control panel

Both X and Y protection relays for Feeder 728 and 730 were replaced in 2015. Relay P546 become obsolete and Powerlink is relying on available spares to maintain the performance. These relays should be replaced between 2028 and 2029 (refer below for examples).

=D1.3 Feeder 730 protection and control panel

Under Frequency Load Shedding (UFLS) has been implemented for feeder 728, 730, 733, 734, 735, 736, 731, 732, 727, 7348, 7233 and 7234 within associated feeder protection relay SEL311L and SEL311C. When the relay is replaced, the requirement for the UFLS function needs to be consulted with Network Operations.

4.3.10 110kV Capacitor bank

Secondary systems for 110kV 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	SPAJ160C	2002	Yes	Yes	Yes	8.30
		SEL-501-2	2002	Yes	Yes	Yes	8.30
		RAICA	2002	No	No	Yes	8.30
	Y	SPAJ140C	2002	Yes	Yes	Yes	8.30
		SPAU121C	2002	Yes	Yes	Yes	8.30
	Point On Wave	E213	2002	Yes	Yes	Yes	8.30
	Local RTU	C50	2002	No	No	Yes	8.30
2 CAP	X	SPAJ160C	2002	Yes	Yes	Yes	8.30
		SEL-501-2	2002	Yes	Yes	Yes	8.30
		RAICA	2002	No	No	Yes	8.30
	Y	SPAJ140C	2002	Yes	Yes	Yes	8.30
		SPAU121C	2002	Yes	Yes	Yes	8.30
	Point On Wave	E213	2002	Yes	Yes	Yes	8.50
	Local RTU	C50	2002	No	No	Yes	8.30

**PLQ Spares*: Limited – Spares will be depleted within 5 years
Yes – The estimated time of depletion is more than 5 years

Secondary systems for 110kV 1 & 2 capacitor banks were installed in 2002. They are located within air-conditioned control cubicles in the switching yard. They are hard to maintain the operational standard due to harsh operating working environment with high failures of air conditioning.

These relocatable capacitor's protection and control devices should be relocated inside the control building. Health index indicates they will reach the end of technical asset life and should be replaced between 2022 and 2023. Replacements should be lined up with major secondary system replacement.

1 and 2 CAP protection and control panel

4.3.11 Power System Control and Monitoring

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

Power System monitoring	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
HSM	IDM+	2017	Yes	Yes	Yes	0.92
PQM	UP-2210	2012	Yes	Yes	Yes	3.40
Travelling Wave Fault Locator	TWS	2010	Yes	Yes	Yes	4.40

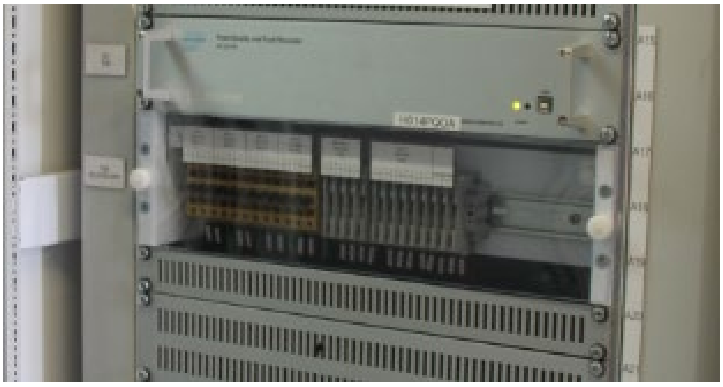
A) High Speed Monitoring (HSM)

High Speed Monitoring (HSM) was implemented to provide synchronized information for AEMO and Powerlink to manage and investigate power system incidents. Dedicated GPS clock has been installed for HSM to provide high accurate synchronized information. These 18 channel Qualitrol IDM+ was commissioned in 2017 and are in good condition. There is no condition driven replacement required until 2037.

High Speed Monitoring device

B) Power Quality Monitoring (PQM)

1 x UP-2210 device has been installed to monitoring the power quality of 110kV network at H014 Middle Ridge. This device was installed at 2012 and are in good condition. There is no condition driven replacement required until 2032.



Power Quality Monitoring Panel

C) Travelling wave fault locator

Travelling fault locator TWS has been installed to accurately locate a fault. The device was installed in 2010. The device has experienced triggering issues due to the network arrangement due to attenuated travelling wave signal for the transformer ended feeder. Powerlink is trialling SEL-T400L to provide accurate fault locating information based on travelling wave for Feeder 9907 and 9908. Once testing successfully, the TWS will be replaced with SEL-T400L unit under major secondary system replacement.

Qualitrol TWS unit

D) GIC (Geomagnetically Induced Current) Monitoring System

Geomagnetically Induced Current (GIC) monitoring system was implemented based on DC transducer for Auto Transformer 5 neutral to monitor the GIC level in 2012. To further understand the GIC level on 330kV side, optical CT was installed to monitor GIC on 5 Transformer 330kV side in 2014. They are in good condition. There are no condition driven replacements required until 2032 and 2034.

GIC transformer neutral monitoring system

Transformer HV GIC monitoring system

4.4 Metering

Secondary systems for metering at H014 Middle Ridge are listed in a table below:

Metering	Revenue and Check Meter	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
Feeder 7234	Revenue	2000-0400 1A Cl 0 5	2009	No	Yes	Yes	5.10
	Check	2000-0400 1A Cl 0 5	2008	No	Yes	Yes	5.30
Feeder 728	Revenue	2000-0400 1A Cl 0 5	2009	No	Yes	Yes	5.10
	Check	2000-0400 1A Cl 0 5	2009	No	Yes	Yes	5.10
Feeder 733	Revenue	2000-0400 1A Cl 0 5	2009	No	Yes	Yes	5.10
	Check	2000-0400 1A Cl 0 5	2009	No	Yes	Yes	5.10
Feeder 736	Revenue	2000-0400 1A Cl 0 5	2009	No	Yes	Yes	5.10
	Check	2000-0400 1A Cl 0 5	2009	No	Yes	Yes	5.10
Feeder 727	Revenue	2000-0400 1A Cl 0 5	2004	No	Yes	Yes	7.40
	Check	2000-0400 1A Cl 0 5	2004	No	Yes	Yes	7.40
Feeder 7233	Revenue	2000-0400 1A Cl 0 5	2009	No	Yes	Yes	5.10
	Check	2000-0400 1A Cl 0 5	2009	No	Yes	Yes	5.10
Feeder 730	Revenue	2000-0400 1A Cl 0 5	2009	No	Yes	Yes	5.10
	Check	2000-0400 1A Cl 0 5	2009	No	Yes	Yes	5.10
Feeder 734	Revenue	2000-0400 1A Cl 0 5	2009	No	Yes	Yes	5.10
	Check	2000-0400 1A Cl 0 5	2009	No	Yes	Yes	5.10
Feeder 735	Revenue	2000-0400 1A Cl 0 5	2009	No	Yes	Yes	5.10
	Check	2000-0400 1A Cl 0 5	2009	No	Yes	Yes	5.10
Feeder 7348	Revenue	2000-0400 1A Cl 0 5	2009	No	Yes	Yes	4.70
	Check	2000-0400 1A Cl 0 5	2011	No	Yes	Yes	4.10

EDMI energy metering devices are utilized to meter Middle Ridge-Postmans Ridge feeder 727 and installed in 2004. Health index indicates these metering equipment will reach the end of technical asset life and should be replaced with major associated major secondary system replacement between 2024 and 2025.

Feeder 727 metering panel (+6A8)

Revenue and check meter equipment for Feeder 7234, 728, 733, 736, 7233, 730, 734, 735 and 7348 were replaced in about 2009. Health index shows that these devices will reach the end of technical asset life and should be replaced with associated major secondary system replacement between 2028 and 2029.

Metering panel (+6A9, +7A8 and 7A9)

Metering data is currently interrogated via dial-up PSTN netowrk. The National Broadband Netowrk (NBN) is rolling out across Queensland and the change in the Telstra's core network to an IP based network. The change in technology has meant that serial communication lines via the public PSTN have become less reliable and problematic. As such, Powerlink has developed a solution to migrate PSTN metering to IP based metering. All meters with dial-up connection should be migrated to IP based meter with major secondary system replacement.

4.5 Non-bays

Secondary systems for Non-bays at H014 Middle Ridge are detailed in a table below:

NBay	Relay & control	Model	Startup Date	Still Manufactured?	Manufacture Support?	PLQ Spares	Health Index
Local control	LCF RTU (110kV)	C50	2005	No	No	Yes	7.00
	LCF RTU (330/275kV)	C50	2005	No	No	Yes	7.00
	HMI	Blade 150	2009	No	No	Limited	10.00
SCADA	NSC1 (110kV)	C50	2005	No	No	Yes	7.00
	NSC2 (110kV)	C50	2005	No	No	Yes	7.00
	NSC1 (330/275kV)	C50	2004	No	No	Yes	7.50
	NSC2 (330/275kV)	C50	2004	No	No	Yes	7.50
Central Control	Comms RTU (+5)	C50	2002	No	No	Yes	8.30
	Common RTU (+6)	C50	2005	No	No	Yes	7.00
	Common RTU (+7)	C50	2005	No	No	Yes	7.00
	Common RTU (+8)	C50	2005	No	No	Yes	7.00
	Router	[redacted]	2010	Yes	Yes	Yes	8.90
Master OpsWAN (+5)	Ethernet switch	[redacted]	2006	Yes	Yes	Yes	10.00
	Port Server	Easy Server II	2006	Yes	Yes	Yes	10.00
	Server	PL1600R/500	2002	Yes	Yes	Yes	10.00
OpsWAN Station (+6)	Ethernet switch	[redacted]	2005	Yes	Yes	Yes	10.00
	Port Server	Easy Server II	2005	Yes	Yes	Yes	10.00
OpsWAN Station (+7)	Ethernet switch	[redacted]	2005	Yes	Yes	Yes	10.00
	Port Server	Easy Server II	2005	Yes	Yes	Yes	10.00
OpsWAN Station (+8)	Ethernet switch	[redacted]	2005	Yes	Yes	Yes	10.00
	Port Server	Easy Server II	2005	Yes	Yes	Yes	10.00
OpsWAN Camera	Camera 1	VC-C4R	2002	Yes	Yes	Yes	10.00
	Camera 2	VC-C4R	2002	Yes	Yes	Yes	10.00
	Camera 3	VB-C10R	2005	Yes	Yes	Yes	10.00
	Camera 4	VB-C1-R	2005	Yes	Yes	Y es	10.00
Timing (+6)		TCG01	2005	Yes	Yes	Yes	7.00
Timing (+7)		TCG01	2011	Yes	Yes	Yes	4.50
Timing (+8)		TCG01	2005	Yes	Yes	Yes	7.00

4.5.1 SCADA, Control and OpsWAN

There are 2 x OptoNet rings, one for 330/275kV and another for 110kV bays.

Dedicated SCADA paths have been implemented for 330/275kV and 110kV secondary systems. The SCADA system in Ring 1 (330/275kV) and Ring 2 (110kV) has independent NSC1 and NSC2 RTU to implement 2 x dual SCADA paths based on DNP3 serial. The SCADA serial protocol is being phased out because of expensive serial infrastructures and low fault tolerance. They should be migrated to DNP over IP. Health index indicates that SCADA RTUs will reach the end of technical asset life and should be replaced between 2024 and 2025.

Local control LCF RTUs were installed in 2005. They will reach the end of technical asset life and should be replaced by 2025. Blade 150 is used for the local control. There are only limited spares available. The HMI functionality of Blade 150 needs to be replaced with major secondary system replacement.

LCF and SCADA RTUs (330/275kV and 110kV)

Majority of OpsWAN equipment were installed between 2005 and 2006. These devices should be replaced with major secondary system replacement to maintain the operational standards.

Comms and common RTUs were installed between 2002 and 2005. These devices become obsolete and Powerlink is currently relying on spares to maintain its operation. Health index shows that these devices will reach the end of useful asset life and should be replaced by 2025.

OpsWAN network and Comms and Common RTUs

Timing clock was installed for Building +6 and +8 in 2005. It needs to be replaced by 2025 to maintain the reliability. Timing clock Building +7 was replace in 2011 and there is no condition-driven replacement required until 2031.

4.5.2 Auxiliary supply

The 415VAC auxiliary supplies are derived from two 11kV/415V 300kVA 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.

415VAC station transformer and AC changeover board

The AC distribution boards in Building +6, +7 and 8 were commissioned in 2002 and are in fair condition. There are no condition driven replacement required until 2037-2042.


AC distribution board within building +6, +7 and +8

The dual 125VDC battery banks were replaced in 2018 and are in good condition. Associated DC rectifiers were installed in 2009 and should be replaced by 2029 (refer below for examples).

125VDC Batteries and charger in Building +6 and +8

Dual 48VDC battery and associated chargers were replaced in 2008. Battery banks will reach the end of technical asset life and should be replaced by 2023 while chargers to be replaced in 2028.

4.6 Telecommunication

Communication systems at H014 Middle Ridge consist of fibre optic technology. Majority of PDH MUX equipment were installed between 2005 and 2007. SDH equipment were was replaced in 2012. MPLS networks were established in 2014. They have been providing reliable services for protection and control systems. Associated communication cards for SDH network are still supportable and repairable. However, [redacted] no longer supports the PDH equipment. There are some cards available from [redacted] but not all cards are 100% compatible. Failure of any of the PDH equipment could result extended outage depending on which cards fail. Failure of the PDH equipment could result in the failed [redacted] PDH equipment being replaced with an [redacted] equivalent installation.

MUX equipment

Site Infrastructure & MPLS panel

5. Summary of H14 Middle Ridge Asset Health

The asset health of major equipment of H014 Middle Ridge 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 H014 Middle Ridge are summarized in the following table below.

Protection and control equipment condition and replacement recommendation									Marshalling kiosk/Cable condition and replacement recommendation			
Bay	Functional Loc.	Description	Model number	Start-up date	Manufacturer	Life Span	HI	Recommendation Replacement by	Item	Startup Date	HI	To be replaced by
=KD1 110kV 1 Bus	H014-SSS-1BU4-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00	2025	110kV 1 Bus marshalling kiosk	7/08/2005	3.56	2040-2045
	H014-SSS-1BU4-XPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC	MFAC34	24/04/2005	ALSTOM	20 Years	7.00		110kV 1 Bus VT box	7/08/2005	3.56	2040-2045
	H014-SSS-1BU4-XPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12	MVAX12	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-1BU4-XPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13	MVAJ13	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-1BU4-XPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13	MVAJ13	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-1BU4-XPROT	RELAY CB FAIL BUS TRIP RACK	CB FAIL TRIP RACK	24/04/2005	RMS	20 Years	7.00					
	H014-SSS-1BU4-XPROT	RELAY CB FAIL BUS TRIP RACK	CB FAIL TRIP RACK	24/04/2005	RMS	20 Years	7.00					
	H014-SSS-1BU4-YPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC	MFAC34	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-1BU4-YPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12	MVAX12	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-1BU4-YPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13	MVAJ13	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-1BU4-YPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13	MVAJ13	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-1BU4-YPROT	RELAY CB FAIL BUS TRIP RACK	CB FAIL TRIP RACK	24/04/2005	RMS	20 Years	7.00					
	H014-SSS-1BU4-YPROT	RELAY CB FAIL BUS TRIP RACK	CB FAIL TRIP RACK	24/04/2005	RMS	20 Years	7.00					
=KC1 275kV 1 Bus	H014-SSS-1BU5-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00	2025-2026	1 Bus marshalling kiosk	24/04/2005	3.64	2040-2045
	H014-SSS-1BU5-XPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC	MFAC34	24/04/2005	ALSTOM	20 Years	7.00		1 BUS VT box	24/04/2005	3.64	2040-2045
	H014-SSS-1BU5-XPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12	MVAX12	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-1BU5-XPROT	RELAY CB FAIL BUS TRIP RACK	CB FAIL TRIP RACK	24/04/2005	RMS	20 Years	7.00					
	H014-SSS-1BU5-XPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13	MVAJ13	20/05/2005	AREVA	20 Years	6.90					
	H014-SSS-1BU5-YPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13	MVAJ13	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-1BU5-YPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC	MFAC34	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-1BU5-YPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12	MVAX12	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-1BU5-YPROT	RELAY CB FAIL BUS TRIP RACK	CB FAIL TRIP RACK	24/04/2005	RMS	20 Years	7.00					
=KD2 110kV 2 Bus	H014-SSS-2BU4-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00	2025	110kV 2 Bus marshalling kiosk	7/08/2005	3.56	2040-2045
	H014-SSS-2BU4-XPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC	MFAC34	24/04/2005	ALSTOM	20 Years	7.00		110kV 2 Bus VT box	7/08/2005	3.56	2040-2045
	H014-SSS-2BU4-XPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12	MVAX12	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-2BU4-XPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13	MVAJ13	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-2BU4-XPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13	MVAJ13	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-2BU4-XPROT	RELAY CB FAIL BUS TRIP RACK	CB FAIL TRIP RACK	24/04/2005	RMS	20 Years	7.00					
	H014-SSS-2BU4-XPROT	RELAY CB FAIL BUS TRIP RACK	CB FAIL TRIP RACK	24/04/2005	RMS	20 Years	7.00					
	H014-SSS-2BU4-YPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC	MFAC34	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-2BU4-YPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13	MVAJ13	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-2BU4-YPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13	MVAJ13	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-2BU4-YPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12	MVAX12	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-2BU4-YPROT	CB FAIL BUS TRIP RACK	CB FAIL TRIP RACK	24/04/2005	RMS	20 Years	7.00					
	H014-SSS-2BU4-YPROT	RELAY CB FAIL BUS TRIP RACK	CB FAIL TRIP RACK	24/04/2005	RMS	20 Years	7.00					
=KC2 275kV 2 Bus	H014-SSS-2BU5-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00	2025-2026	2 Bus marshalling kiosk	8/02/2005	3.70	2040-2045
	H014-SSS-2BU5-XPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13	MVAJ13	24/04/2005	ALSTOM	20 Years	7.00		2 BUS VT box	8/02/2005	3.70	2040-2045
	H014-SSS-2BU5-XPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC	MFAC34	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-2BU5-XPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12	MVAX12	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-2BU5-XPROT	RELAY CB FAIL BUS TRIP RACK	CB FAIL TRIP RACK	24/04/2005	RMS	20 Years	7.00					
	H014-SSS-2BU5-YPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13	MVAJ13	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-2BU5-YPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC	MFAC34	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-2BU5-YPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12	MVAX12	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-2BU5-YPROT	RELAY CB FAIL BUS TRIP RACK	CB FAIL TRIP RACK	24/04/2005	RMS	20 Years	7.00					
=KD3 110kV 3 Bus	H014-SSS-3BU4-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00	2025	110kV 3 Bus marshalling kiosk	7/08/2005	3.56	2040-2045
	H014-SSS-3BU4-XPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC	MFAC34	24/04/2005	ALSTOM	20 Years	7.00		110kV 3 Bus VT box	7/08/2005	3.56	2040-2045
	H014-SSS-3BU4-XPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13	MVAJ13	24/04/2005	ALSTOM	20 Years	7.00		Control cables	7/08/2005	3.56	2040-2045
	H014-SSS-3BU4-XPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13	MVAJ13	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-3BU4-XPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12	MVAX12	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-3BU4-XPROT	RELAY CB FAIL BUS TRIP RACK	CB FAIL TRIP RACK	24/04/2005	RMS	20 Years	7.00					
	H014-SSS-3BU4-XPROT	RELAY CB FAIL BUS TRIP RACK	CB FAIL TRIP RACK	24/04/2005	RMS	20 Years	7.00					
	H014-SSS-3BU4-YPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC	MFAC34	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-3BU4-YPROT	RELAY TRIPPING SUPPLY FAIL ALSTOM MVAX12	MVAX12	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-3BU4-YPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13	MVAJ13	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-3BU4-YPROT	RELAY TRIPPING LOW BURDEN ALSTOM MVAJ13	MVAJ13	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-3BU4-YPROT	RELAY CB FAIL BUS TRIP RACK	CB FAIL TRIP RACK	24/04/2005	RMS	20 Years	7.00					
	H014-SSS-3BU4-YPROT	RELAY CB FAIL BUS TRIP RACK	CB FAIL TRIP RACK	24/04/2005	RMS	20 Years	7.00					
=D00 110kV 2-3 Bus coupler	H014-SSS-401--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	13/08/2005	FOXBORO	20 Years	6.80	2025	110kV 2-3 bus coupler marshalling kiosk	10/02/2005	3.70	2040-2045
	H014-SSS-401--XPROT	RELAY CBMAN GE C60 (WITH W6T MODULE)	C60 (2.82) WITH W6T	13/08/2005	GE	20 Years	6.80		Control cables	10/02/2005	3.70	2040-2045
	H014-SSS-401--YPROT	RELAY CBMAN SEL-351-1 (1A)	SEL-351-1 (1A)	13/08/2005	SCHWEITZER	20 Years	6.80					
=D16 110kV 1-3 Bus	H014-SSS-402--XPROT	RELAY CBMAN GE C60 (WITH W6T MODULE)	C60 (2.82) WITH W6T	24/12/2004	GE	20 Years	7.10	2025	110kV 1-3 bus coupler marshalling kiosk	10/02/2005	3.70	2040-2045
	H014-SSS-402--YPROT	RELAY CBMAN SEL-351-1 (1A)	SEL-351-1 (1A)	24/12/2004	SCHWEITZER	20 Years	7.10		Control cables	10/02/2005	3.70	2040-2045
=D09 110kV 1-2 Bus	H014-SSS-411--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	18/09/2005	FOXBORO	20 Years	6.80	2025	110kV 1-2 bus coupler marshalling kiosk	10/02/2005	3.70	2040-2045
	H014-SSS-411--XPROT	RELAY CBMAN GE C60 (WITH W6T MODULE)	C60 (2.82) WITH W6T	18/09/2005	GE	20 Years	6.80		Control cables	10/02/2005	3.70	2040-2045
	H014-SSS-411--YPROT	RELAY CBMAN SEL-351-1 (1A)	SEL-351-1 (1A)	18/09/2005	SCHWEITZER	20 Years	6.80					
=D11.3 1T 110kV	H014-SSS-441--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00	2025	1 Transformer 110kV marshalling kiosk and control cables	24/04/2005	3.64	2040-2045
	H014-SSS-441--XPROT	RELAY CBMAN GE C60 (WITH W6T MODULE)	C60 (2.82) WITH W6T	24/04/2005	GE	20 Years	7.00					
	H014-SSS-441--YPROT	RELAY CBMAN SEL-351-1 (1A)	SEL-351-1 (1A)	24/04/2005	SCHWEITZER	20 Years	7.00					
=D10.1 2T 110kV	H014-SSS-442--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	29/05/2005	FOXBORO	20 Years	6.90	2025	2 Transformer 110kV marshalling kiosk and control cables	31/07/1987	8.71	2022-2027
	H014-SSS-442--XPROT	RELAY CBMAN GE C60 (WITH W6T MODULE)	C60 (2.82) WITH W6T	29/05/2005	GE	20 Years	6.90					
	H014-SSS-442--YPROT	RELAY CBMAN SEL-351-1 (1A)	SEL-351-1 (1A)	29/05/2005	SCHWEITZER	20 Years	6.90					
=D08.2 3T 110kV	H014-SSS-443--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	2/07/2005	FOXBORO	20 Years	6.90	2025	3 Transformer 110kV marshalling kiosk and control cables	31/07/1987	8.71	2022-2027
	H014-SSS-443--XPROT	RELAY CBMAN GE C60 (WITH W6T MODULE)	C60 (2.82) WITH W6T	2/07/2005	GE	20 Years	6.90					
	H014-SSS-443--YPROT	RELAY CBMAN SEL-351-1 (1A)	SEL-351-1 (1A)	2/07/2005	SCHWEITZER	20 Years	6.90					
=D15.1 110kV Cap 1	H014-SSS-481--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	29/07/2002	FOXBORO	20 Years	8.30	2022-2023	110kV 1 Cap marshalling kiosk and control cables	28/02/2002	4.54	2037-2042
	H014-SSS-481--POWAVE	RELAY POINT ON WAVE ABB E213	SWITCHSYNC E213	28/03/2002	ABB	20 Years	8.50					
	H014-SSS-481--XPROT	RELAY CAP PROTN ABB SPAJ160C	SPAJ160C	29/07/2002	ABB	20 Years	8.30					
	H014-SSS-481--XPROT	RELAY O/C 5A SEL-501-2	SEL-501-2 (5A)	29/07/2002	SCHWEITZER	20 Years	8.30					
	H014-SSS-481--XPROT	RELAY CB FAIL ABB RAICA	RAICA	29/07/2002	ABB	20 Years	8.30					
	H014-SSS-481--YPROT	RELAY OVERCURRENT ABB SPAJ140C	SPAJ140C	29/07/2002	ABB	20 Years	8.30					
	H014-SSS-481--YPROT	RELAY OVERVOLTAGE ABB SPAU121C	SPAU121C	29/07/2002	ABB	20 Years	8.30					
=D15.3 110kV Cap 2	H014-SSS-482--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	29/07/2002	FOXBORO	20 Years	8.30	2022-2023	110kV 1 Cap marshalling kiosk and control cables	28/02/2002	4.54	2037-2042
	H014-SSS-482--POWAVE	RELAY POINT ON WAVE ABB E213	SWITCHSYNC E213	3/04/2002	ABB	20 Years	8.50					

	H014-SSS-482--XPROT	RELAY CAP PROTN ABB SPAJ160C	SPAJ160C	29/07/2002	ABB	20 Years	8.30					
	H014-SSS-482--XPROT	RELAY O/C 5A SEL-501-2	SEL-501-2 (5A)	29/07/2002	SCHWEITZER	20 Years	8.30					
	H014-SSS-482--XPROT	RELAY CB FAIL ABB RAICA	RAICA	29/07/2002	ABB	20 Years	8.30					
	H014-SSS-482--YPROT	RELAY OVERCURRENT E/F ABB SPAJ140C	SPAJ140C	29/07/2002	ABB	20 Years	8.30					
	H014-SSS-482--YPROT	RELAY OVERVOLTAGE ABB SPAU121C	SPAU121C	29/07/2002	ABB	20 Years	8.30					
=C01 275kV bus coupler 501	H014-SSS-501--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00	2025-2026	Coupler 501 marshalling kiosk	24/04/2005	3.64	2040-2045
	H014-SSS-501--XPROT	RELAY CBMAN GE C60 (WITH W6T MODULE)	C60 (2.82) WITH W6T	24/04/2005	GE	20 Years	7.00					
	H014-SSS-501--YPROT	RELAY CBMAN SEL-352 (1A) (3U)	SEL-352 (1A) (3U)	24/04/2005	SCHWEITZER	20 Years	7.00					
=C02 275kV bus coupler 502	H014-SSS-502--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00	2025-2026	Coupler 502 marshalling kiosk	24/04/2005	3.64	2040-2045
	H014-SSS-502--XPROT	RELAY CBMAN GE C60 (WITH W6T MODULE)	C60 (2.82) WITH W6T	24/04/2005	GE	20 Years	7.00					
	H014-SSS-502--YPROT	RELAY CBMAN SEL-352 (1A) (3U)	SEL-352 (1A) (3U)	24/04/2005	SCHWEITZER	20 Years	7.00					
=C03 275kV bus coupler 503	H014-SSS-503--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00	2025-2026	Coupler 503 marshalling kiosk	24/04/2005	3.64	2040-2045
	H014-SSS-503--XPROT	RELAY CBMAN GE C60 (WITH W6T MODULE)	C60 (2.82) WITH W6T	24/04/2005	GE	20 Years	7.00					
	H014-SSS-503--YPROT	RELAY CBMAN SEL-352 (1A) (3U)	SEL-352 (1A) (3U)	24/04/2005	SCHWEITZER	20 Years	7.00					
=C04 275kV bus coupler 504	H014-SSS-504--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	18/07/2007	FOXBORO	20 Years	5.90	2027-2028	Coupler 504	18/07/2007	3.00	2042-2047
	H014-SSS-504--XPROT	RELAY CB MGMT GE C60 (VER 2.93 FIRMWARE)	C60 (VER 2.93)	18/07/2007	GE	20 Years	5.90					
	H014-SSS-504--YPROT	RELAY CB MGMT SEL 352 1A, 125Vdc, 4U	SEL-352 (1A) (4U)	18/07/2007	SCHWEITZER	20 Years	5.90					
=C02.2 1T 275kV	H014-SSS-541--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00	2025	Transformer 1 CB marshalling kiosk	24/04/2005	3.64	2040-2045
	H014-SSS-541--XPROT	RELAY DIFF 25-325V 1POLE ALSTOM MFAC14	MFAC14	24/04/2005	ALSTOM	20 Years	7.00		Transformer 1 VT box	24/04/2005	3.64	2040-2045
	H014-SSS-541--XPROT	RELAY TRANSF O/LOAD GE F35	F35 (2.82)	24/04/2005	GE	20 Years	7.00					
	H014-SSS-541--XPROT	RELAY TRANSF DIFF GE T60	T60 (3.48)	24/04/2005	GE	20 Years	7.00					
	H014-SSS-541--YPROT	RELAY BIASED DIFF SEL-387-5 (1A) (3U)	SEL-387-5 (1A) (3U)	24/04/2005	SCHWEITZER	20 Years	7.00					
=C01.2 2T 275kV	H014-SSS-542--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00	2025	Transformer 2 CVT box	24/04/2005	3.64	2040-2045
	H014-SSS-542--XPROT	RELAY TRANSF O/LOAD GE F35	F35 (2.82)	24/04/2005	GE	20 Years	7.00		Transformer 2 CB marshalling kiosk	24/04/2005	3.64	2040-2045
	H014-SSS-542--XPROT	RELAY TRANSF DIFF GE T60	T60 (3.48)	24/04/2005	GE	20 Years	7.00					
	H014-SSS-542--YPROT	RELAY BIASED DIFF SEL-387-5 (1A) (3U)	SEL-387-5 (1A) (3U)	24/04/2005	SCHWEITZER	20 Years	7.00					
=C01.1 3T 275kV	H014-SSS-543--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00	2025	Transformer 3 CB marshalling kiosk	24/04/2005	3.64	2040-2045
	H014-SSS-543--XPROT	RELAY TRANSF DIFF GE T60	T60 (3.48)	24/04/2005	GE	20 Years	7.00		Transformer 3 VT box	24/04/2005	3.64	2040-2045
	H014-SSS-543--XPROT	RELAY TRANSF O/LOAD GE F35	F35 (2.82)	24/04/2005	GE	20 Years	7.00		Control cables	24/04/2005	3.64	2040-2045
	H014-SSS-543--YPROT	RELAY BIASED DIFF SEL-387-5 (1A) (3U)	SEL-387-5 (1A) (3U)	24/04/2005	SCHWEITZER	20 Years	7.00					
=C03.2 4T 330/275kV	H014-SSS-544--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00	2025-2027	Transformer 4 marshalling kiosk	24/04/2005	3.64	2040-2045
	H014-SSS-544--XPROT	RELAY DIFF 25-325V 1POLE ALSTOM MFAC14	MFAC14	24/04/2005	ALSTOM	20 Years	7.00		Transformer 4 VT box	24/04/2005	3.64	2040-2045
	H014-SSS-544--XPROT	RELAY TRANSF O/LOAD GE F35	F35 (2.82)	24/04/2005	GE	20 Years	7.00					
	H014-SSS-544--XPROT	RELAY TRANSF DIFF GE T60	T60 (3.48)	24/04/2005	GE	20 Years	7.00					
	H014-SSS-544--YPROT	RELAY BIASED DIFF SEL-387-5 (1A) (3U)	SEL-387-5 (1A) (3U)	24/04/2005	SCHWEITZER	20 Years	7.00					
=C04.2 5T 330/275kV	H014-SSS-545--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	27/11/2008	FOXBORO	20 Years	5.20	2025-2027	Transformer 5 CB marshalling kiosk	18/07/2007	3.00	2042-2047
	H014-SSS-545--XPROT	RELAY DIFF 25-325V 1POLE AREVA MFAC14	MFAC14	18/07/2007	AREVA	20 Years	5.90		Control cables	18/07/2007	3.00	2042-2047
	H014-SSS-545--XPROT	RELAY TRANSF DIFF GE T60 (3.48)	T60 (3.48)	18/07/2007	GE	20 Years	5.90					
	H014-SSS-545--XPROT	RELAY TRANSF O/LOAD GE F35 (2.93)	F35 (2.93)	18/07/2007	GE	20 Years	5.90					
	H014-SSS-545--YPROT	RELAY BIASED DIFF SEL-387-5 (1A) (3U)	SEL-387-5 (1A) (3U)	18/07/2007	SCHWEITZER	20 Years	5.90					
=B01 330kV 3 Cap	H014-SSS-683--POWAVE	RELAY POW SWITCHSYNC F236 - SPAR CB	SWITCHSYNC F236	19/08/2011	ABB	20 Years	7.30	2031-2032	330kV Capacitor 3 marshalling kiosk and control cables	19/08/2011	1.83	2046-2051
	H014-SSS-683--XPROT	RELAY CAP PROTN ABB SPAJ160C	SPAJ160C	19/08/2011	ABB	20 Years	3.80					
	H014-SSS-683--XPROT	RELAY CAP PROTN ABB SPAJ160C	SPAJ160C	19/08/2011	ABB	20 Years	3.80					
	H014-SSS-683--XPROT	RELAY CAP PROTN ABB SPAJ160C	SPAJ160C	19/08/2011	ABB	20 Years	3.80					
	H014-SSS-683--XPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC	MFAC34	19/08/2011	ALSTOM	20 Years	3.80					
	H014-SSS-683--XPROT	RELAY CB MGMT GE C60 (5.22) 100BASE FX	C60 (J00) (V5.22)	19/08/2011	GE	20 Years	4.00					
	H014-SSS-683--YPROT	RELAY CB MGMT SEL-451-5 1A, 125VDC	SEL-451-5 (1A)	19/08/2011	SCHWEITZER	20 Years	3.80					
	H014-SSS-683--YPROT	RELAY CAP PROTN ABB SPAJ160C	SPAJ160C	19/08/2011	ABB	20 Years	3.80					
	H014-SSS-683--YPROT	RELAY CAP PROTN ABB SPAJ160C	SPAJ160C	19/08/2011	ABB	20 Years	3.80					
	H014-SSS-683--YPROT	RELAY CAP PROTN ABB SPAJ160C	SPAJ160C	19/08/2011	ABB	20 Years	3.80					
	H014-SSS-683-BAYCONT		C50	19/08/2011		20 Years	4.16					
=B02 330kV 4 Cap	H014-SSS-684--POWAVE	RELAY POW SWITCHSYNC F236 - SPAR CB	SWITCHSYNC F236	25/11/2011	ABB	20 Years	7.30	2031-2032	330kV Capacitor 4 marshalling kiosk and control cables	19/08/2011	1.83	2046-2051
	H014-SSS-684--XPROT	RELAY CB MGMT GE C60 (5.22) 100BASE FX	C60 (J00) (V5.22)	25/11/2011	GE	20 Years	4.00					
	H014-SSS-684--XPROT	RELAY CAP PROTN ABB SPAJ160C	SPAJ160C	25/11/2011	ABB	20 Years	3.70					
	H014-SSS-684--XPROT	RELAY CAP PROTN ABB SPAJ160C	SPAJ160C	25/11/2011	ABB	20 Years	3.70					
	H014-SSS-684--XPROT	RELAY CAP PROTN ABB SPAJ160C	SPAJ160C	25/11/2011	ABB	20 Years	3.70					
	H014-SSS-684--XPROT	RELAY DIFF ALSTOM MFAC34 RANGE 25-325VAC	MFAC34	25/11/2011	ALSTOM	20 Years	3.70					
	H014-SSS-684--YPROT	RELAY CB MGMT SEL-451-5 1A, 125VDC	SEL-451-5 (1A)	25/11/2011	SCHWEITZER	20 Years	3.70					
	H014-SSS-684--YPROT	RELAY CAP PROTN ABB SPAJ160C	SPAJ160C	25/11/2011	ABB	20 Years	3.70					
	H014-SSS-684--YPROT	RELAY CAP PROTN ABB SPAJ160C	SPAJ160C	25/11/2011	ABB	20 Years	3.70					
	H014-SSS-684--YPROT	RELAY CAP PROTN ABB SPAJ160C	SPAJ160C	25/11/2011	ABB	20 Years	3.70					
	H014-SSS-684-BAYCONT		C50	19/08/2011		20 Years	4.16					
=D13.3 Spare 5	H014-SSS-711--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	13/08/2005	FOXBORO	20 Years	6.80	2025	Spare 5 bay marshalling kiosk and control cables	21/05/2004	3.90	2039-2044
	H014-SSS-711--PSPIT	DEWAR DM1200 PROT SIG DIG 90-320V SUPPLY	DM1200 DIGITAL	13/08/2005	DEWAR	20 Years	6.80					
	H014-SSS-711--XPROT	RELAY CURRENT DIFF GE L90 (2T+N6U) V3.48	L90 2T : D00 N6U UXX	13/08/2005	GE	20 Years	6.80					
	H014-SSS-711--YPROT	RELAY DISTANCE SEL 311C 1A	SEL-311C (1A)	13/08/2005	SCHWEITZER	20 Years	6.80					
=D02.3 Feeder 7233	H014-SSS-7233-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	5/12/2009	FOXBORO	20 Years	5.10	2023-2025	Feeder 7233 marshalling kiosk and control cables	16/07/2004	3.86	2039-2044
	H014-SSS-7233-PSDITA	F7233 SIT A1 H014 TO T116 VF PROT SIG	M695	31/03/2006	DEWAR	20 Years	6.50					
	H014-SSS-7233-PSDITB	F7233 SIT B1 H014 TO T116 VF PROT SIG	M695	31/03/2006	DEWAR	20 Years	6.50					
	H014-SSS-7233-XPROT	RELAY DISTANCE SEL 311C 1A	SEL-311C (1A)	2/12/2003	SCHWEITZER	20 Years	7.70					
	H014-SSS-7233-YPROT	RELAY CURRENT DIFF GE L90 (2 TERM+N6U)	L90 2T : D00 N6U UXX	11/11/2003	GE	20 Years	7.70					
=D04.2 Feeder 7234	H014-SSS-7234-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	4/08/2008	FOXBORO	20 Years	5.30	2023-2025	Feeder 7234 marshalling kiosk and control cables	8/07/2004	3.87	2039-2044
	H014-SSS-7234-XPROT	RELAY DISTANCE SEL-311C (1A)	SEL-311C (1A)	5/07/2009	SCHWEITZER	20 Years	4.90					
	H014-SSS-7234-YPROT	RELAY CURRENT DIFF GE L90 (2T+N6U) V3.48	L90 2T : D00 N6U UXX	6/11/2003	GE	20 Years	7.70					
=D03.2 Feeder 727	H014-SSS-727--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	28/09/2005	FOXBORO	20 Years	6.80	2025	Feeder 727 marshalling kiosk and control cables	28/09/2005	3.52	2040-2045
	H014-SSS-727--XPROT	RELAY CURRENT DIFF GE L90 (2T+N6U) V3.48	L90 2T : D00 N6U UXX	28/09/2005	GE	20 Years	6.80					
	H014-SSS-727--YPROT	RELAY DISTANCE SEL 311C 1A	SEL-311C (1A)	28/09/2005	SCHWEITZER	20 Years	6.80					
=D01.2 Feeder 728	H014-SSS-728--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	9/09/2007	FOXBORO	20 Years	5.80	2028-2029	Feeder 728 marshalling kiosk	3/02/2003	4.27	2038-2043
	H014-SSS-728--PSDIT	F728 DIT H014 TO T043 VF PROT SIG	DM1200 VF	1/06/2002	DEWAR	20 Years	8.70					
	H014-SSS-728--XPROT	RELAY CURR DIFF DISTANCE MICOM P546	P546	22/05/2015	SCHNEIDER	20 Years	4.70					
	H014-SSS-728--YPROT	RELAY DIFF 1A SCHWEITZER 311L-7 125VDC	SEL-311L-7 1A, 125V	22/05/2015	SCHWEITZER	20 Years	4.50					
=D01.3 Feeder 730	H014-SSS-730--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	30/09/2007	FOXBORO	20 Years	5.80	2028-2029	Feeder 730 marshalling kiosk	23/06/2004	3.88	2039-2044
	H014-SSS-730--PSDIT	F730 DIT H014 TO T043 VF PROT SIG	DM1200 VF	1/06/2002	DEWAR	20 Years	8.40					
	H014-SSS-730--XPROT	RELAY CURR DIFF DISTANCE MICOM P546	P546	22/05/2015	SCHNEIDER	20 Years	4.70					
	H014-SSS-730--YPROT	RELAY DIFF 1A SCHWEITZER 311L-7 125VDC	SEL-311L-7 1A, 125V	22/05/2015	SCHWEITZER	20 Years	4.50					
=D06.3 Feeder 731	H014-SSS-731--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	21/11/2009	FOXBORO	20 Years	5.10	2025	Feeder 731 marshalling kiosk and control cables	1/03/1999	5.40	2034-2039
	H014-SSS-731--PSPIT	RFL 9745 PROT SIG DIG I/O 48-125V	9745 DIGITAL	21/11/2009	RFL ELECTRONICS	20 Years	5.50					

	H014-SSS-731--XPROT	RELAY DISTANCE MICOM P442 (WITH R/PORT)	P442 (WITH R/PORT)	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-731--YPROT	RELAY DISTANCE SEL 311C 1A	SEL-311C (1A)	5/11/2003	SCHWEITZER	20 Years	7.00					
=D05.2 Feeder 732	H014-SSS-732--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	5/12/2009	FOXBORO	20 Years	5.10	2025	Feeder 732 marshalling kiosk and control cables	4/04/2005	3.65	2040-2045
	H014-SSS-732--PSPIT	RFL 9745 PROT SIG DIG I/O 48-125V	9745 DIGITAL	7/08/2009	RFL ELECTRONICS	20 Years	5.90					
	H014-SSS-732--XPROT	RELAY DISTANCE MICOM P442 (WITH R/PORT)	P442 (WITH R/PORT)	18/09/2006	AREVA	20 Years	6.30					
	H014-SSS-732--YPROT	RELAY DISTANCE SEL 311C 1A	SEL-311C (1A)	2/12/2003	SCHWEITZER	20 Years	7.70					
=D11.1 Feeder 733	H014-SSS-733--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	8/10/2005	FOXBORO	20 Years	6.70	2025	Feeder 733 marshalling kiosk and control cables	24/04/2004	3.92	2039-2044
	H014-SSS-733--XPROT	RELAY CURRENT DIFF GE L90 (2T+N6U) V3.48	L90 2T : D00 N6U UXX	8/10/2005	GE	20 Years	6.70					
	H014-SSS-733--YPROT	RELAY DISTANCE SEL 311C 1A	SEL-311C (1A)	8/10/2005	SCHWEITZER	20 Years	6.70					
=D07.3 Feeder 734	H014-SSS-734--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	4/11/2007	FOXBORO	20 Years	5.70	2027	Feeder 734 marshalling kiosk and control cables	12/07/2004	3.86	2039-2044
	H014-SSS-734--XPROT	RELAY CURRENT DIFF GE L90 (2 TERM+N6U)	L90 2T : D00 N6U UXX	1/12/2007	GE	20 Years	5.70					
	H014-SSS-734--YPROT	RELAY DISTANCE SEL 311C 1A	SEL-311C (1A)	1/12/2007	SCHWEITZER	20 Years	5.70					
=D12.3 Feeder 7348	H014-SSS-7348-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	10/11/2005	FOXBORO	20 Years	6.70	2025	Feeder 7348 marshalling kiosk and control cables	4/03/2011	1.96	2046-2051
	H014-SSS-7348-XPROT	COMMS INTERFACE UNIT ALSTOM P591	P591 (50VDC)	9/06/2011	AREVA	20 Years	3.90					
	H014-SSS-7348-XPROT	RELAY CURR DIFF DISTANCE MICOM P546	P546	4/03/2011	AREVA	20 Years	5.20					
	H014-SSS-7348-YPROT	RELAY DISTANCE SEL 311C 1A	SEL-311C (1A)	10/11/2005	SCHWEITZER	20 Years	6.70					
=D14.3 Feeder 735	H014-SSS-735--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	16/10/2005	FOXBORO	20 Years	6.70	2025	Feeder 735 marshalling kiosk and control cables	16/10/2005	3.50	2040-2045
	H014-SSS-735--PSARBLK	DEWAR DM1200 PROT SIG DIG 90-320V SUPPLY	DM1200 DIGITAL	16/10/2005	DEWAR	20 Years	6.70					
	H014-SSS-735--PSDIT	DEWAR DM1200 PROT SIG DIG 90-320V SUPPLY	DM1200 DIGITAL	16/10/2005	DEWAR	20 Years	6.70					
	H014-SSS-735--XPROT	RELAY DISTANCE MICOM P442 (WITH R/PORT)	P442 (WITH R/PORT)	16/10/2005	AREVA	20 Years	6.70					
	H014-SSS-735--YPROT	RELAY DISTANCE SEL 311C 1A	SEL-311C (1A)	16/10/2005	SCHWEITZER	20 Years	6.70					
=D12.1 Feeder 736	H014-SSS-736--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	4/11/2007	FOXBORO	20 Years	5.70	2027	Feeder 736 marshalling kiosk and control cables	29/08/2005	3.54	2040-2045
	H014-SSS-736--PSDIT	DEWAR DM1200 PROT SIG DIG 20-60V SUPPLY	DM1200 DIGITAL	12/10/2002	DEWAR	20 Years	8.20					
	H014-SSS-736--XPROT	RELAY DISTANCE MICOM P442 (WITH R/PORT)	P442 (WITH R/PORT)	1/12/2007	ALSTOM	20 Years	5.80					
	H014-SSS-736--YPROT	RELAY DISTANCE SEL 311C 1A	SEL-311C (1A)	1/12/2007	SCHWEITZER	20 Years	5.70					
=C02.1 Feeder 831	H014-SSS-831--BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00	2025	Feeder 831 bay marshalling kiosk	24/04/2005	3.64	2040-2045
	H014-SSS-831--PSPIT	RFL 9745 PROT SIG DIG I/O 48-125V	9745 DIGITAL	24/04/2005	RFL ELECTRONICS	20 Years	7.00		Feeder 831 VT box	24/04/2005	3.64	2040-2045
	H014-SSS-831--PSPIT	RFL 9745 PROT SIG DIG I/O 48-125V	9745 DIGITAL	7/06/2005	RFL ELECTRONICS	20 Years	6.90					
	H014-SSS-831--PSPITY	DEWAR DM1200 PROT SIG DIG 90-320V SUPPLY	DM1200 DIGITAL	9/07/2009	DEWAR	20 Years	4.90					
	H014-SSS-831--PSSITA	RFL 9745 PROT SIG DIG I/O 48-125V	9745 DIGITAL	7/06/2005	RFL ELECTRONICS	20 Years	6.90					
	H014-SSS-831--PSSITB	DEWAR DM1200 PROT SIG DIG 90-320V SUPPLY	DM1200 DIGITAL	7/06/2005	DEWAR	20 Years	6.90					
	H014-SSS-831--XPROT	RELAY CBMAN GE C60 (WITH W6T MODULE)	C60 (2.82) WITH W6T	24/04/2005	GE	20 Years	7.00					
	H014-SSS-831--XPROT	RELAY DISTANCE MICOM P442 (WITH R/PORT	P442 (WITH R/PORT)	26/06/2009	AREVA	20 Years	4.90					
	H014-SSS-831--YPROT	RELAY DISTANCE SEL-421 (1A) (5U)	SEL-421 (1A) (5U)	24/04/2005	SCHWEITZER	20 Years	7.00					
=C3.1 Feeder 8848	H014-SSS-8848-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	18/07/2007	FOXBORO	20 Years	5.90	2027	Feeder 8848 CB marshalling kiosk	18/07/2007	3.00	2042-2047
	H014-SSS-8848-PSBLKA	DEWAR DM1200 PROT SIG DIG 90-320V SUPPLY	DM1200 DIGITAL	18/07/2007	DEWAR	20 Years	5.90		Feeder 8848 VT box	18/07/2007	3.00	2042-2047
	H014-SSS-8848-PSBLKB	DEWAR DM1200 PROT SIG DIG 90-320V SUPPLY	DM1200 DIGITAL	18/07/2007	DEWAR	20 Years	5.90					
	H014-SSS-8848-PSSITA	DEWAR DM1200 PROT SIG DIG 90-320V SUPPLY	DM1200 DIGITAL	18/07/2007	DEWAR	20 Years	5.90					
	H014-SSS-8848-PSSITB	RFL 9745 PROT SIG DIG I/O 48-125V	9745 DIGITAL	18/07/2007	RFL ELECTRONICS	20 Years	5.90					
	H014-SSS-8848-XPROT	CURR DIFF RELAY MICOM P544 + 2ND PORT	P544 (+ 2nd Port)	21/06/2005	MICOM	20 Years	6.90					
	H014-SSS-8848-YPROT	RELAY DISTANCE SEL-421 (1A) (5U)	SEL-421 (1A) (5U)	18/07/2007	SCHWEITZER	20 Years	5.90					
=C04.1 Feeder 8849	H014-SSS-8849-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	18/07/2007	FOXBORO	20 Years	5.90	2027	Feeder 8849 marshalling kiosk	18/07/2007	3.00	2042-2047
	H014-SSS-8849-PSPITY	DEWAR DM1200 PROT SIG DIG 90-320V SUPPLY	DM1200 DIGITAL	18/07/2007	DEWAR	20 Years	5.90					
	H014-SSS-8849-PSSITA	DEWAR DM1200 PROT SIG DIG 90-320V SUPPLY	DM1200 DIGITAL	18/07/2007	DEWAR	20 Years	5.90					
	H014-SSS-8849-PSSITB	RFL 9745 PROT SIG DIG I/O 48-125V	9745 DIGITAL	18/07/2007	RFL ELECTRONICS	20 Years	5.90					
	H014-SSS-8849-XPROT	CURR DIFF RELAY MICOM P544 + 2ND PORT	P544 (+ 2nd Port)	4/09/2018	MICOM	20 years	4.10					
	H014-SSS-8849-XPROT	COMMS INTERFACE UNIT ALSTOM P591	P591 (50VDC)	27/04/2015	AREVA	20 Years	2.40					
	H014-SSS-8849-YPROT	RELAY DISTANCE SCHW'ZER 421-5 1A 24 LED	SEL-421-5 (1A) (5U)	8/10/2012	SCHWEITZER	20 Years	4.40					
=B02 Feeder 9907	H014-SSS-9907-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	18/07/2007	FOXBORO	20 Years	5.90	2027	Feeder 9907 VT box	18/07/2007	3.00	2042-2047
	H014-SSS-9907-PSPITY	DEWAR DM1200 PROT SIG DIG 90-320V SUPPLY	DM1200 DIGITAL	2/01/2007	DEWAR	20 Years	6.10					
	H014-SSS-9907-PSSITA1	DEWAR DM1200 PROT SIG DIG 90-320V SUPPLY	DM1200 DIGITAL		DEWAR	20 Years	4.50					
	H014-SSS-9907-PSSITA2	RFL 9745 PROT SIG DIG I/O 48-125V	9745 DIGITAL	18/07/2007	RFL ELECTRONICS	20 Years	5.90					
	H014-SSS-9907-PSSITB1	DEWAR DM1200 PROT SIG DIG 90-320V SUPPLY	DM1200 DIGITAL	18/07/2007	DEWAR	20 Years	5.90					
	H014-SSS-9907-PSSITB2	RFL 9745 PROT SIG DIG I/O 48-125V	9745 DIGITAL	18/07/2007	RFL ELECTRONICS	20 Years	5.90					
	H014-SSS-9907-XPROT	CURR DIFF RELAY MICOM P544 + 2ND PORT	P544 (+ 2nd Port)	18/07/2007	MICOM	20 Years	5.90					
	H014-SSS-9907-YPROT	RELAY DISTANCE SEL-421 (1A) (5U)	SEL-421 (1A) (5U)	18/07/2007	SCHWEITZER	20 Years	5.90					
=B01 Feeder 9908	H014-SSS-9908-BAYCONT	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00	2025	Feeder 9908 VT box	24/04/2005	3.64	2040-2045
	H014-SSS-9908-PSPITY	DEWAR DM1200 PROT SIG DIG 90-320V SUPPLY	DM1200 DIGITAL	24/04/2005	DEWAR	20 Years	7.00					
	H014-SSS-9908-PSSITA1	DEWAR DM1200 PROT SIG DIG 90-320V SUPPLY	DM1200 DIGITAL	24/04/2005	DEWAR	20 Years	7.00					
	H014-SSS-9908-PSSITA2	RFL 9745 PROT SIG DIG I/O 48-125V	9745 DIGITAL		RFL ELECTRONICS	20 Years	7.00					
	H014-SSS-9908-PSSITB1	DEWAR DM1200 PROT SIG DIG 90-320V SUPPLY	DM1200 DIGITAL	24/04/2005	DEWAR	20 Years	7.00					
	H014-SSS-9908-PSSITB2	RFL 9745 PROT SIG DIG I/O 48-125V	9745 DIGITAL	24/04/2005	RFL ELECTRONICS	20 Years	5.90					
	H014-SSS-9908-XPROT	CURR DIFF RELAY MICOM P544 + 2ND PORT	P544 (+ 2nd Port)	10/11/2004	MICOM	20 Years	7.20					
	H014-SSS-9908-XPROT	COMMS INTERFACE UNIT ALSTOM P591	P591 (50VDC)	24/04/2005	ALSTOM	20 Years	7.00					
	H014-SSS-9908-YPROT	RELAY DISTANCE SEL-421 (1A) (5U)	SEL-421 (1A) (5U)	24/04/2005	SCHWEITZER	20 Years	7.00					
Metering	H014-SSS-METR-REVMET1	METER KWH/KVARH EDMI (CHECK)	2000-0400 1A Cl 0.5	4/08/2008	EDMI	20 Years	5.30	2028-2029	N/A			
	H014-SSS-METR-REVMET1	METER KWH/KVARH EDMI (REVENUE)	2000-0400 1A Cl 0.5	2/01/2009	EDMI	20 Years	5.10					
	H014-SSS-METR-REVMET10	METER KWH/KVARH EDMI 2000-0400 CL 0.5	2000-0400 1A Cl 0.5	7/11/2009	EDMI	20 Years	4.70					
	H014-SSS-METR-REVMET10	METER KWH/KVARH EDMI 2000-0400 CL 0.5	2000-0400 1A Cl 0.5	4/03/2011	EDMI	20 Years	4.10					
	H014-SSS-METR-REVMET2	METER KWH/KVARH EDMI (REVENUE)	2000-0400 1A Cl 0.5	2/01/2009	EDMI	20 Years	5.10					
	H014-SSS-METR-REVMET2	METER KWH/KVARH EDMI (CHECK)	2000-0400 1A Cl 0.5	2/01/2009	EDMI	20 Years	5.10					
	H014-SSS-METR-REVMET3	METER KWH/KVARH EDMI (REVENUE)	2000-0400 1A Cl 0.5	2/01/2009	EDMI	20 Years	5.10					
	H014-SSS-METR-REVMET3	METER KWH/KVARH EDMI	2000-0400 1A Cl 0.5	2/01/2009	EDMI	20 Years	5.10					
	H014-SSS-METR-REVMET4	METER KWH/KVARH EDMI (REVENUE)	2000-0400 1A Cl 0.5	2/01/2009	EDMI	20 Years	5.10					
	H014-SSS-METR-REVMET4	METER KWH/KVARH EDMI (CHECK)	2000-0400 1A Cl 0.5	2/01/2009	EDMI	20 Years	5.10					
	H014-SSS-METR-REVMET5	METER KWH/KVARH EDMI (REVENUE)	2000-0400 1A Cl 0.5	1/07/2004	EDMI	20 Years	7.40	2024-2025				
	H014-SSS-METR-REVMET5	METER KWH/KVARH EDMI (CHECK)	2000-0400 1A Cl 0.5	1/07/2004	EDMI	20 Years	7.40					
	H014-SSS-METR-REVMET6	METER KWH/KVARH EDMI (REVENUE)	2000-0400 1A Cl 0.5	2/01/2009	EDMI	20 Years	5.10	2028-2029				
	H014-SSS-METR-REVMET6	METER KWH/KVARH EDMI	2000-0400 1A Cl 0.5	2/01/2009	EDMI	20 Years	5.10					
	H014-SSS-METR-REVMET7	METER KWH/KVARH EDMI (REVENUE)	2000-0400 1A Cl 0.5	2/01/2009	EDMI	20 Years	5.10					
	H014-SSS-METR-REVMET7	METER KWH/KVARH EDMI (CHECK)	2000-0400 1A Cl 0.5	2/01/2009	EDMI	20 Years	5.10					
	H014-SSS-METR-REVMET8	METER KWH/KVARH EDMI (REVENUE)	2000-0400 1A Cl 0.5	2/01/2009	EDMI	20 Years	5.10					
	H014-SSS-METR-REVMET8	METER KWH/KVARH EDMI	2000-0400 1A Cl 0.5	2/01/2009	EDMI	20 Years	5.10					
	H014-SSS-METR-REVMET9	METER KWH/KVARH EDMI (REVENUE)	2000-0400 1A Cl 0.5	2/01/2009	EDMI	20 Years	5.10					
	H014-SSS-METR-REVMET9	METER KWH/KVARH EDMI (CHECK)	2000-0400 1A Cl 0.5	2/01/2009	EDMI	20 Years	5.10					

Non Bay	H014-SSS-NBAY-LCF	LOCAL CONTROL FACILITY PC X TERMINAL	V90L XPe 1GB/512MB	13/02/2009	WYSE	10 Years	10.00	2025	N/A			
	H014-SSS-NBAY-LCF6PCX	LOCAL CONTROL FACILITY PC X TERMINAL	V90L XPe 1GB/512MB	28/11/2008	WYSE	10 Years	10.00					
	H014-SSS-NBAY-LCF7	LOCAL CONTROL FACILITY PC X TERMINAL	V90L XPe 1GB/512MB	28/11/2008	WYSE	10 Years	10.00					
	H014-SSS-NBAY-LCF8110	LOCAL CONTROL FACILITY PC X TERMINAL	V90L XPe 1GB/512MB	13/02/2009	WYSE	10 Years	10.00					
	H014-SSS-NBAY-LCF8275	LOCAL CONTROL FACILITY SUN BLADE	BLADE 150	12/02/2009	SUN	10 Years	10.00					
	H014-SSS-NBAY-LCFINT	REMOTE TERMINAL UNIT FOXBORO C50	C50	29/07/2002	FOXBORO	20 Years	8.30					
	H014-SSS-NBAY-LCFINT6	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00					
	H014-SSS-NBAY-LCFINT8	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00					
	H014-SSS-NBAY-NSCLINK1	REMOTE TERMINAL UNIT FOXBORO C50	C50	29/07/2002	FOXBORO	20 Years	8.30					
	H014-SSS-NBAY-NSCLINK2	REMOTE TERMINAL UNIT FOXBORO C50	C50	29/07/2002	FOXBORO	20 Years	8.30					
	H014-SSS-NBAY-NSCLNK16	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00					
	H014-SSS-NBAY-NSCLNK18	REMOTE TERMINAL UNIT FOXBORO C50	C50	21/04/2004	FOXBORO	20 Years	7.50					
	H014-SSS-NBAY-NSCLNK26	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00					
	H014-SSS-NBAY-NSCLNK28	REMOTE TERMINAL UNIT FOXBORO C50	C50	21/04/2004	FOXBORO	20 Years	7.50					
	H014-SSS-NBAY-OWCAM1	VIDEO CAMERA	VC-C4R	15/08/2002	CANON	10 Years	10.00	2025				
	H014-SSS-NBAY-OWCAM2	VIDEO CAMERA	VC-C4R	15/08/2002	CANON	10 Years	10.00					
	H014-SSS-NBAY-OWCAM3	CANON ETHERNET CAMERA	VB-C10R	24/04/2005	CANON	10 Years	10.00					
	H014-SSS-NBAY-OWCAM4	CANON ETHERNET CAMERA	VB-C10R	24/04/2005	CANON	10 Years	10.00					
	H014-SSS-NBAY-OWNTWK	PORT SERVER	STEC990223	12/06/2001	STALLION	10 Years	10.00					
	H014-SSS-NBAY-OWNTWK	PORT SERVER	STEC990220	12/06/2001	STALLION	10 Years	10.00					
	H014-SSS-NBAY-OWNTWK1	PORT SERVER	EASY SERVER II	22/09/2006	STALLION	10 Years	10.00					
	H014-SSS-NBAY-OWNTWK1	SWITCH ETHERNET	[redacted]	22/09/2006	[redacted]	10 Years	10.00					
	H014-SSS-NBAY-OWNTWK2	SWITCH ETHERNET	[redacted]	22/09/2006	[redacted]	10 Years	10.00					
	H014-SSS-NBAY-OWNTWK2	PORT SERVER	EASY SERVER II	22/09/2006	STALLION	10 Years	10.00					
	H014-SSS-NBAY-OWNTWK2	ROUTER [redacted] 48VDC - OPSWAN	[redacted]	27/04/2010	[redacted]	10 Years	8.90					
	H014-SSS-NBAY-OWNTWK6	SWITCH	[redacted]	24/04/2005	[redacted]	10 Years	10.00					
	H014-SSS-NBAY-OWNTWK6	PORT SERVER	EASY SERVER II	24/04/2005	STALLION	10 Years	10.00					
	H014-SSS-NBAY-OWNTWK7	SWITCH	[redacted]	24/04/2005	[redacted]	10 Years	10.00					
	H014-SSS-NBAY-OWNTWK7	PORT SERVER	EASY SERVER II	24/04/2005	STALLION	10 Years	10.00					
	H014-SSS-NBAY-OWNTWK8	PORT SERVER	EASY SERVER II	11/02/2005	STALLION	10 Years	10.00					
	H014-SSS-NBAY-OWNTWK8	SWITCH	[redacted]	11/02/2005	[redacted]	10 Years	10.00					
	H014-SSS-NBAY-OWSERV	SERVER	PL1600R/500	15/08/2002	COMPAQ	10 Years	10.00					
	H014-SSS-NBAY-PSPM1	RECORDER QUALITROL IDM+	RECORDER QUALITROL I	12/01/2017	QUALITROL	20 years	0.92	2037				
	H014-SSS-NBAY-PWRQUAL1	PQ ANALYSER UNIPOWER UP-2210 VT & REF IN	UP-2210	5/07/2012	UNIPOWER	20 Years	3.40	2032				
	H014-SSS-NBAY-RTUCOM	REMOTE TERMINAL UNIT FOXBORO C50	C50	29/07/2002	FOXBORO	20 Years	8.30	2025				
	H014-SSS-NBAY-RTUCOM	RTU FOXBORO C50 TRANSF COOL & AC SUPPLY	C50	11/03/2003	FOXBORO	20 Years	8.30					
	H014-SSS-NBAY-RTUCOM6	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00					
	H014-SSS-NBAY-RTUCOM7	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00					
	H014-SSS-NBAY-RTUCOM8	REMOTE TERMINAL UNIT FOXBORO C50	C50	24/04/2005	FOXBORO	20 Years	7.00					
	H014-SSS-NBAY-TIMING6	GPS CLOCK - TEKRON TCG01	TCG01	24/04/2005	TEKRON	20 Years	7.00	2025				
	H014-SSS-NBAY-TIMING7	GPS CLOCK TEKRON TCG01-D:1	TCG01-D09.009	22/03/2011	TEKRON	20 Years	4.50	2031				
	H014-SSS-NBAY-TIMING8	GPS CLOCK - TEKRON TCG01	TCG01	24/04/2005	TEKRON	20 Years	7.00	2025				
	H014-SSS-NBAY-TWFL	FAULT LOCATOR HATHAWAY TWS 5 CIRCUIT	TWS 5 CIRCUIT	11/06/2010	HATHAWAY	20 Years	4.40	2025				
Note	The physical disconnect terminals for CT circuits for marshalling kiosks should be replaced to mitigate CT open circuit risks with major secondary system replacement. Option such as in-situ or new replacement for the marshalling kiosk depends on required duration of primary plant outage.											

6. Recommendations

Based on the condition assessment, the main recommendations for the replacement of secondary systems equipment at H014 Middle Ridge are:-

1. Replace all secondary systems for 110kV 1 and 2 Cap and relocate all secondary systems in the control building by 2023

2. Conduct following replacements by 2025:-
   - Replace the physical disconnect terminals of CT circuits on marshalling kiosks including
     - =KC1 and =KC2 - 275kV bus zones
     - Diameter =C1 – 275kV coupler 501, 2 Transformer and 3 Transformer
     - Diameter C2 – 275kV coupler 502, 1 Transformer and Feeder 831
     - Diameter =C3 - 275kV coupler 503, 4 Transformer (excluding Feeder 8848)
     - =KD1, =KD2 and =KD3 = 110kV bus zones
     - 110kV bus coupler 401, 402 and 403
     - 110kV 1 Transformer
     - 110kV Feeder 711 (Bay Spare 5), 7233, 7234, 727, 731, 732, 733, 735 (except Feeder 7348)
   - Replace marshalling cubicle for 2T and 3T 110kV and associated control cables
   - Replace all secondary systems for 330kV/275kV 4 Transformer and the protection and control panel
   - Replace all secondary systems for 330kV Feeder 9908 and the protection and control panel
   - Replace all secondary systems for 275kV 1 and 2 bus including associated protection and control panels
   - Replace all secondary systems for 275kV bus coupler 501, 502, 503 and associated protection and control panels
   - Replace all secondary systems for 1T, 2T and 3T 275kV and associated protection and control panels
   - Replace all secondary systems for 275kV Feeder 831 and the protection and control panel
   - Replace all secondary systems for 110kV 1, 2 and 3 bus including associated protection and control panels
   - Replace all secondary systems for 110kV bus coupler 401, 402 and 411 and associated protection and control panels
   - Replace all secondary systems for 1T, 2T and 3T 110kV and associated protection and control panels
   - Replace all secondary systems for 110kV Feeder 711 (Bay Spare 5), 7233, 7234, 727, 731, 732, 733, 735, 7348 and the protection and control panel
   - Replace all Comms and common RTU in building +5, +6, +7 and +8
   - Replace all SCADA RTU for 330/275KV and 110kV and upgrade the DNP serial to DNP over IP
   - Replace Blade 150 HMI Sun Workstation
   - Replace all OpsWAN equipment (including all OpsWAN cameras) in the brick building, +5, +6, +7 and +8
   - Replace timing clock for Building +6 and +8
   - Replace energy metering equipment for Feeder 727 and migrate to IP based metering
   - Migrate the rest of meters to IP based meters
   - Replace the existing traveling wave based fault locator for feeder 9907 and 9908 with an approved new unit such as SEL-T400L

3. Carry out following replacements by 2027:-
   - Replace the physical disconnect terminals of CT circuits on marshalling kiosks including
     - Diameter =C4 – 275kV coupler 504, 5 Transformer and Feeder 8849
     - Bay =C3.1 – Feeder 8848
     - 110kV Feeder 728, 730, 734, 736
   - Replace all secondary systems for 330kV Feeder 9907 and the protection and control panel
   - Replace all secondary systems for 330/275kV 5T and associated protection and control panels
   - Replace all secondary systems for 275kV bus coupler 504 and the protection and control panels
   - Replace all secondary systems for 275kV Feeder 8848, 8849 and the protection and control panel
   - Replace all secondary systems for 110kV Feeder 728, 730, 734, 736 and the protection and control panel
   - Replace metering equipment for Feeder 7234, 728, 733, 736, 7233, 730, 734, 735 and 7348
   - Replace all 125VDC batter chargers in Building +6, +7 and +8
   - Replace 48VDC battery banks

4. Carry out following replacements by 2032
   - Replace the physical disconnect terminals of CT circuits on marshalling kiosks including
     - 330kV 3 & 4 Cap
   - Replace all secondary systems for 330kV 3 & 4 Cap and associated protection and control panels
   - Replace timing clock for Building +7
   - Replace UP-2210 power quality monitoring
   - Replace GIC monitoring based on traditional DC transducers

5. Carry out following replacements by 2037
   - Replace High Speed Monitoring (HSM) IDM+
   - Replace GIC monitoring electronic devices based on flexible Optical CT

7. References

(1) National Electricity Rules (NER) Version 100, AEMC, 20/10/2017
(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

Planning Statement	November 2019
Title	CP.02760 – H014 Middle Ridge Secondary Systems Replacement – Planning Statement[1]
Zone	Tarong
Need Driver	Emerging compliance risks arising from the condition and obsolescence of Middle Ridge's ageing secondary systems.
Network Limitation	Middle Ridge Substation is needed to meet Powerlink Queensland's N-1-50MW/600MWh reliability obligations and maintain the power transfer capability between South West and South East Queensland.
Pre-requisites	None

Executive Summary

Ageing and obsolete secondary systems at Middle Ridge 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 Guidelines[2].

Energy Queensland forecasts confirm there is an enduring need to maintain electricity supply into the Toowoomba and Darling Downs area. The removal or reconfiguration of the Middle Ridge Substation due to secondary system failure/obsolescence would violate Powerlink's N-1-50MW/600MWh Transmission Authority reliability standard and significantly impact the power transfer capability of the Tarong grid section.

The preferred network solution for Powerlink to continue to meet its statutory obligations is the replacement of the at-risk secondary systems by the end of 2025.

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

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

[2] 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

1. Introduction

Located just south of Toowoomba, the Middle Ridge 330/275/110kV Substation is a major transmission node between South West and South East Queensland, as well as an essential bulk supply point for local and South East Queensland loads, including the Toowoomba and Darling Downs area.

A condition assessment of the 330/275/110kV secondary systems at H014 Middle Ridge Substation has confirmed that the secondary systems, commissioned from 2002 to 2007, are approaching the end of their technical life and recommends that the secondary systems be replaced by the end of the 2025.

This condition driver has triggered the need to assess the enduring network need for the Middle Ridge Substation configuration and function.

This report assesses the impact that removal of the functionality enabled by the secondary systems 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 Middle Ridge Substation.

[redacted]

Figure 1: Middle Ridge connects South West and South East Queensland

Figure 2 shows the existing connection configuration of the Middle Ridge Substation and surrounding substations.

[redacted]

Figure 2: Middle Ridge area operating diagram

2. Middle Ridge Demand Forecast

As shown in Figure 2 the substation consists of

1. Two 330kV transformer-ended feeders from Millmerran Substation
2. The 275kV switchyard, which has feeders connecting to Tarong and Greenbank substations and 3 x 275/110kV transformers
3. The 110kV switchyard provides 12 x 132kV connections to supply the Toowoomba and Granite Belt areas and connection to west of Ipswich. Generation is also connected into the 110kV network supplied from Middle Ridge. This includes approximately 275MW of semi-scheduled embedded solar farms (Oakey 1, Oakey 2, Yarranlea, Warwick, Maryrorough) and a 30MW non-scheduled embedded generator Daandine Power Station. The 288MW scheduled Oakey Power Station is also connected to this 110kV network.

Middle Ridge feeders form part of the Tarong grid section, and the removal or reconfiguration of the network across and around this grid section will affect the connectivity of generation in South West Queensland and impact the ability to supply load in South East Queensland.

The historical load duration curves for Middle Ridge Substation are shown in Figure 3.

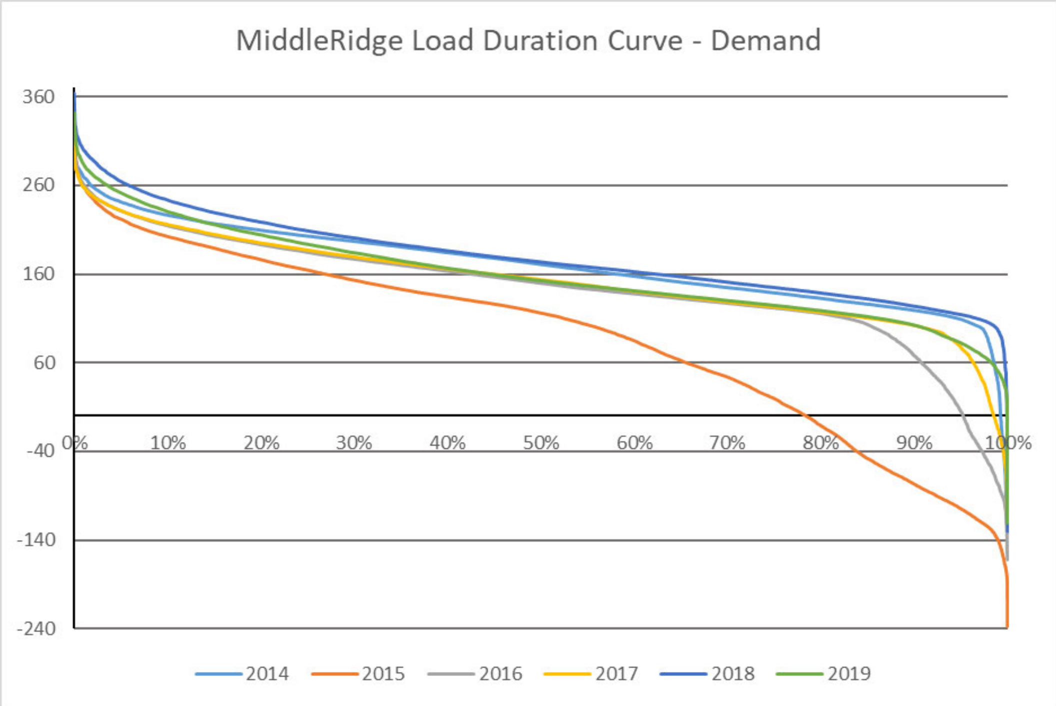


Figure 3: Load Curve for Middle Ridge 110kV

From load forecast, peak load is not expected to change materially in coming years. The historical and forecast load is shown in Figure 4.

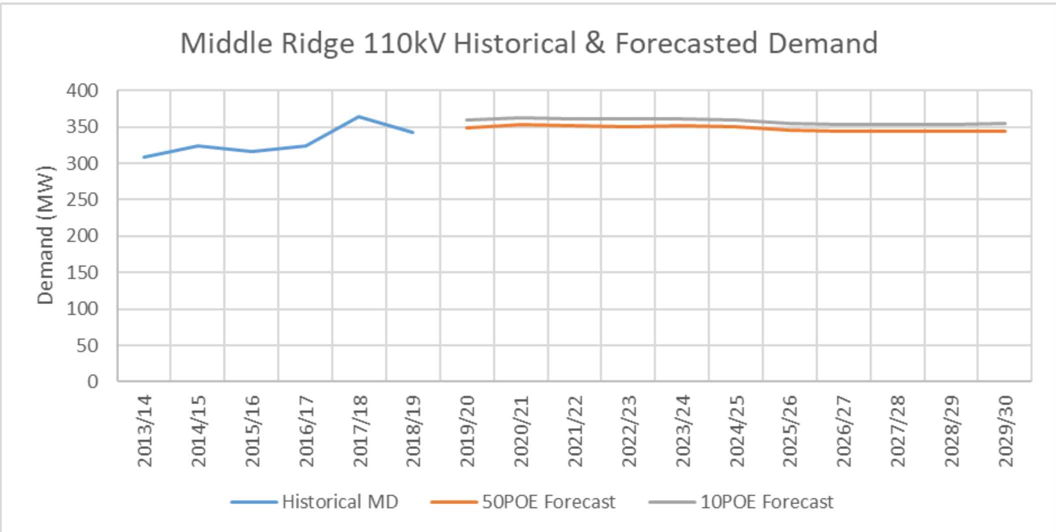


Figure 4: Historical and forecast Demand for Middle Ridge 110kV

Figure 4 shows the forecast summer maximum demand on the 110kV network is not expected to change in coming years. There are no major additional loads proposed or committed in the Middle Ridge region.

Middle Ridge Substation also facilitates generation flow from regional power stations including Oakey and Daandine, and there is interest from proponents of significant asynchronous generators in the area surrounding Middle Ridge that have not yet committed.

3. Statement of Investment Need

As outlined in Section 2 the Middle Ridge Substation is a major transmission node between South West and South East Queensland, as well as an essential bulk supply point for local and South East Queensland loads, including Toowoomba and Darling Downs area.

Removing the switching functionality would have a major impact on the performance of the Tarong grid section as well reliability of supply to the load areas above. The through-flow between Millmerran and Greenbank substations could be maintained, notwithstanding the issues of energising the resulting long 330/275kV line (approximately 200km) and providing adequate 330/275kV transformer protection), but at the expense of not being able to meet the load supplied from Middle Ridge through a single 275kV line from Tarong.

The secondary systems are required to operate the Middle Ridge Substation. Therefore, the secondary systems are required to avoid system failures that would result in loss of load in excess of Powerlink’s N-1-50MW / 600MWh reliability standard. There would be loss of supply to Toowoomba and Darling Downs area, including loads at Tangkam, Postman Ridge, Torrington, Yarranlea, Warwick, Toowoomba and Kearney Springs, as well as loss of supply to local generation. There would also be a significant impact on the capacity of the Tarong grid section.

4. Network Risk

The table below presents the load at risk, as well as the energy at risk, at Middle Ridge.

Table 1. Load at Risk

Load At Risk	Contingency Event	Quantity	2020	2030
All Middle Ridge	275/110kV Transformer (1T, 2T or 3T)	Max (MW)	163	158
		Average (MW)	7	7
		24h Energy Max (MWh)	1265	1172
		24h Energy Average (MWh)	179	173
Tangkam	110kV Feeders 731 & 732	Max (MW)	69	68
		Average (MW)	32	32
		24h Energy Max (MWh)	1094	1083
		24h Energy Average (MWh)	775	777
Torrington	110kV Feeders 7233 & 7234	Max (MW)	92	91
		Average (MW)	51	52
		24h Energy Max (MWh)	1810	1807
		24h Energy Average (MWh)	1229	1237
Yarranlea	110kV Feeders 733 & 734	Max (MW)	88	93
		Average (MW)	23	24
		24h Energy Max (MWh)	2050	2129
		24h Energy Average (MWh)	548	567
Toowoomba and Kearneys Spring	110kV Feeders 728 & 730	Max (MW)	97	96
		Average (MW)	48	49
		24h Energy Max (MWh)	1875	1853
		24h Energy Average (MWh)	1152	1165
Warwick and Stanthorpe	110kV Feeders 735 & 736	Max (MW)	64	60
		Average (MW)	30	30
		24h Energy Max (MWh)	990	991
		24h Energy Average (MWh)	711	714
Postmans Ridge and Gatton	110kV Feeders 727 & 7348	Max (MW)	77	79
		Average (MW)	28	28
		24h Energy Max (MWh)	1202	1220
		24h Energy Average (MWh)	669	672

5. Non Network Options

The Middle Ridge 330/275/110kV Substation is required to maintain the reliability of supply (Toowoomba and Darling Downs area and support required power transfers between south west and south east Queensland. As a result, no viable non-network alternatives are envisaged. Viable non-network solutions would need to provide supply to individual 110kV Middle Ridge loads, (as per the load at risk table), to reduce the scope of this project.

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

6. Network Options

6.1 Proposed Option to address the identified need

As validated in Table 1 there is an enduring need for all 110kV feeder connections and 275/110kV transformer connections to reliably supply the Energy Queensland loads. In addition the 110kV network connects a number of generators as outlined in Section 2.

There are 2 x 50MVAr capacitor banks connected to the 110kV bus. Both capacitor banks are regularly switched-in to provide local voltage support during high load conditions and generally support reactive power losses during higher transfers between SWQ and SEQ.

The only opportunity to optimise the scope of the secondary systems project is in relation to the Tarong to Middle Ridge 275kV feeder (831). This 275kV line is not required for Powerlink to meets its reliability obligations. However, removal of this line does increases the network losses. A play-back of historical snapshots show that these losses may be valued at between $200k to $400k per annum. This is greater than the annualised cost of the secondary system component. There has also been enquiries to connect wind farms to this feeder.

Therefore, the recommended network solution is to replace all 330kV, 275kV and 110kV secondary systems at H014 Middle Ridge Substation by end of 2025. This option ensures that all reliability of supply and asset condition criteria is met as well as maintaining the power transfer capability between South West and South East Queensland.

Further details of condition assessment for the Woolooga substation secondary systems and their individual recommended replacement timing can be found in Reference 1.

6.2 Option Considered but Not Proposed

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

6.2.1 Do Nothing

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

7. Recommendations

Powerlink has reviewed the condition of the secondary systems at Middle Ridge Substation and anticipates they will reach end of technical service life by 2025. It is therefore recommended that the systems be replaced by December 2025.

Retaining Middle Ridge Substation will allow Powerlink to continue to meet its required reliability obligations (N-1-50MW/600MWh) and maintain power transfer capability between South West and South East Queensland.

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

8. References

1. "H014 Middle Ridge Secondary Systems Condition Assessment Report March 2019", Powerlink, A3073040, 2019.
2. "Criticality of the Tarong to Middle Ridge 275kV circuit (F831) ", Powerlink, A1999269
3. Transmission Annual Planning Report 2020
4. Asset Management Plan 2021
5. Asset Planning Criteria Framework

Base Case Risk Summary Report

CP.02760 Middle Ridge Secondary Systems Replacement

Version Number	Objective ID	Date	Description
1.0	A3373721	24/06/2020	Original document.

1 Purpose

The purpose of this model is to quantify the base case risk cost profiles for the secondary systems at Middle Ridge substation which is proposed for reinvestment under CP.02760. Base case risk costs have been analysed over a ten-year study horizon.

2 Key Assumptions

In calculating the potential unserved energy (USE) arising from a failure of the ageing and obsolete secondary systems at Middle Ridge substation, the following modelling assumptions have been made:

- Spares for secondary system equipment items have been assumed to be available prior to the point of expected spares depletion. After this point the cost and time to return the secondary system back to service increases significantly;
- Historical load profiles have been used when assessing the likelihood of unserved energy under failure events;
- Due to the network and substation configuration, unserved energy generally accrues under concurrent failure events and consideration has been given to potential feeder trip events within the wider south west Queensland area;
- Middle Ridge substation supplies a mixture of residential, agricultural and commercial loads. Historical load data and estimates have been used to analyse the proportion of these load types, and a weighted average VCR of $33,045/MWh has been used when evaluating network risk cost; and
- VCRs for residential, agricultural and industry load types within the relevant climate zone published within the AER's 2019 Value of Customer Reliability Review Final Report have been used within this risk cost assessment.

3 Base Case Risk Analysis

3.1 Risk Categories

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

3.2 Secondary Systems Analysis

This section analyses the risks presented by the relevant secondary systems at Middle Ridge substation.

Table 1 - Risks associated with at risk secondary systems

	Mode of failure	
Equipment	**Peaceful**	**Explosive**
Secondary systems	Network risks (unserved energy due to concurrent network element outages). Financial risks to respond on-site and replace failed secondary systems in an emergency manner[1].	N/A

[1] Secondary systems spares are modelled as being available until equipment reaches 20 years of age. After this time, the cost to replace obsolete spares in an emergency manner is higher which is modelled as increased financial risk cost.

3.3 Base Case Risk Cost

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

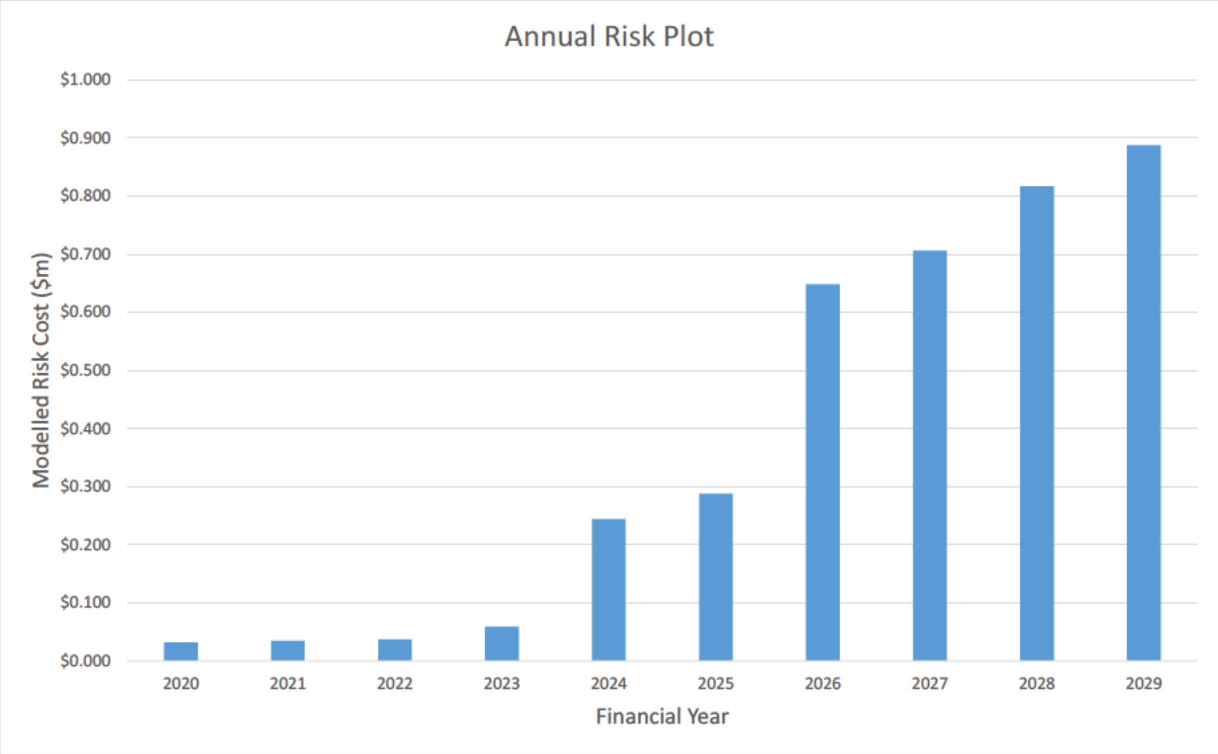


Figure 1 – Middle Ridge secondary systems total risk cost

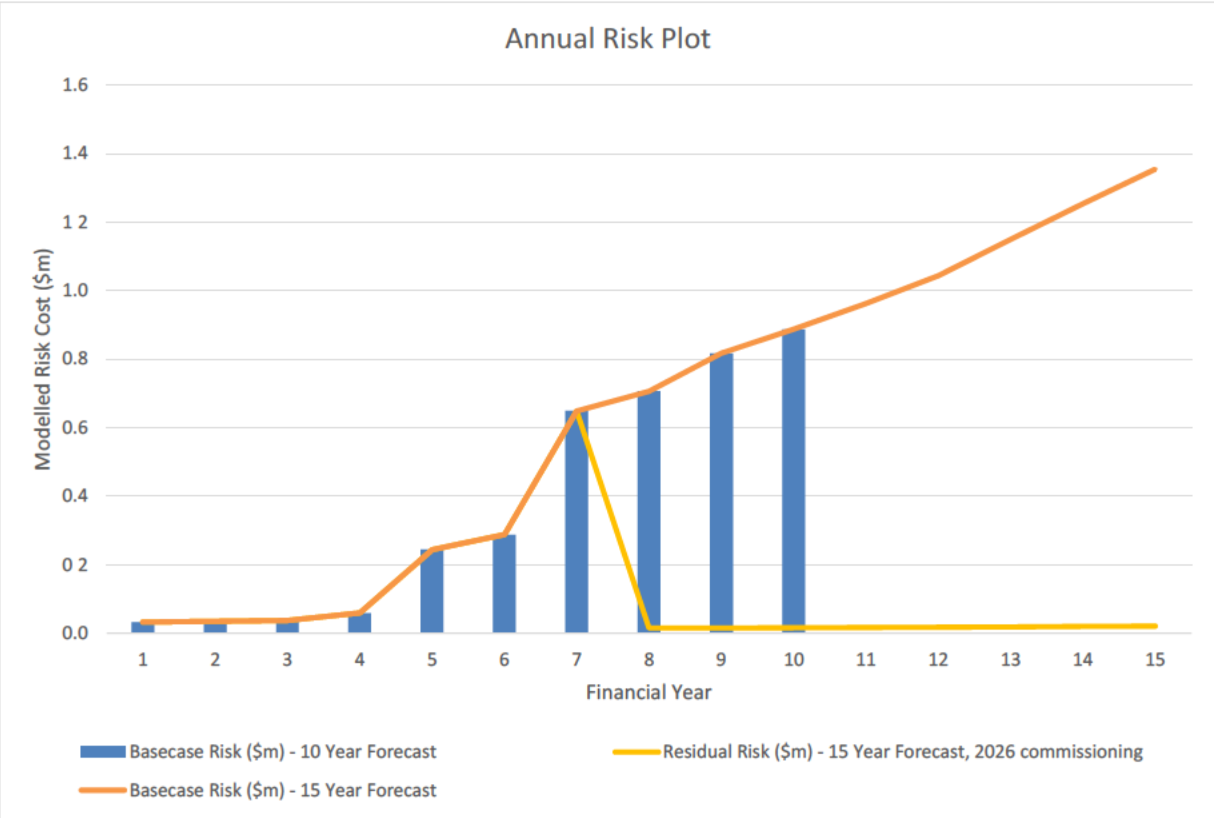


Figure 2 – Middle Ridge secondary systems risk cost (10 and 15 years)

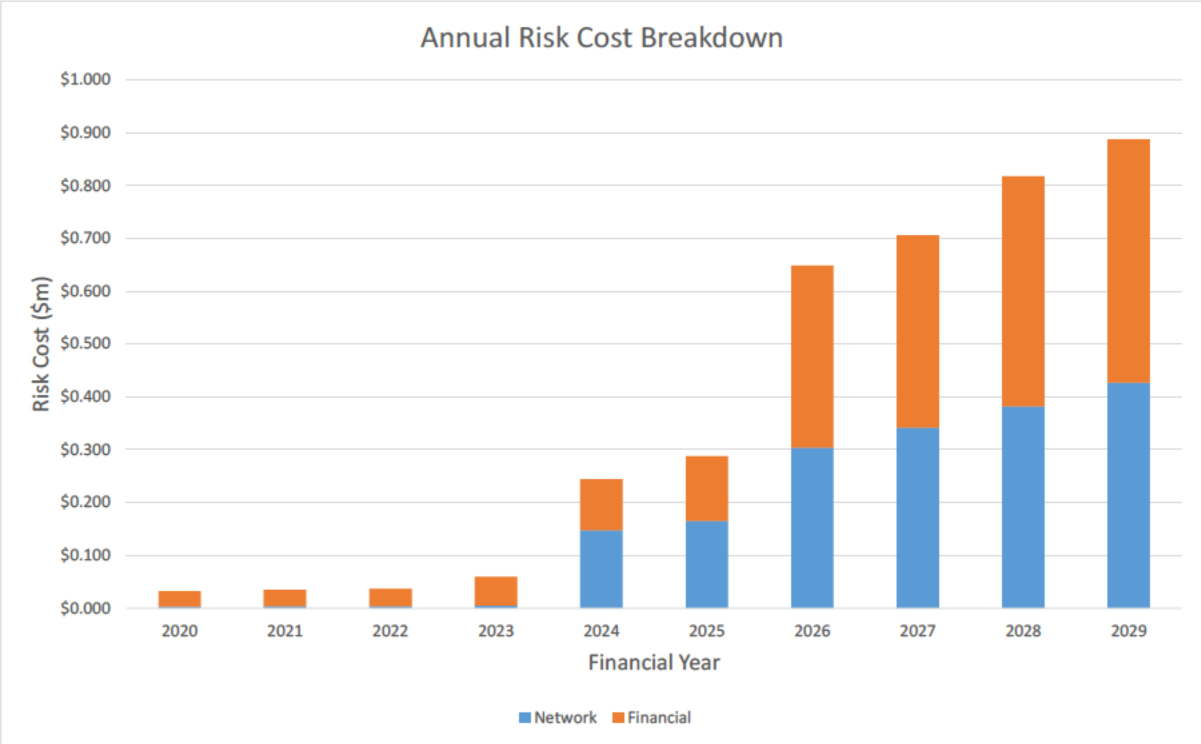


Figure 3 – Middle Ridge secondary systems risk cost by category

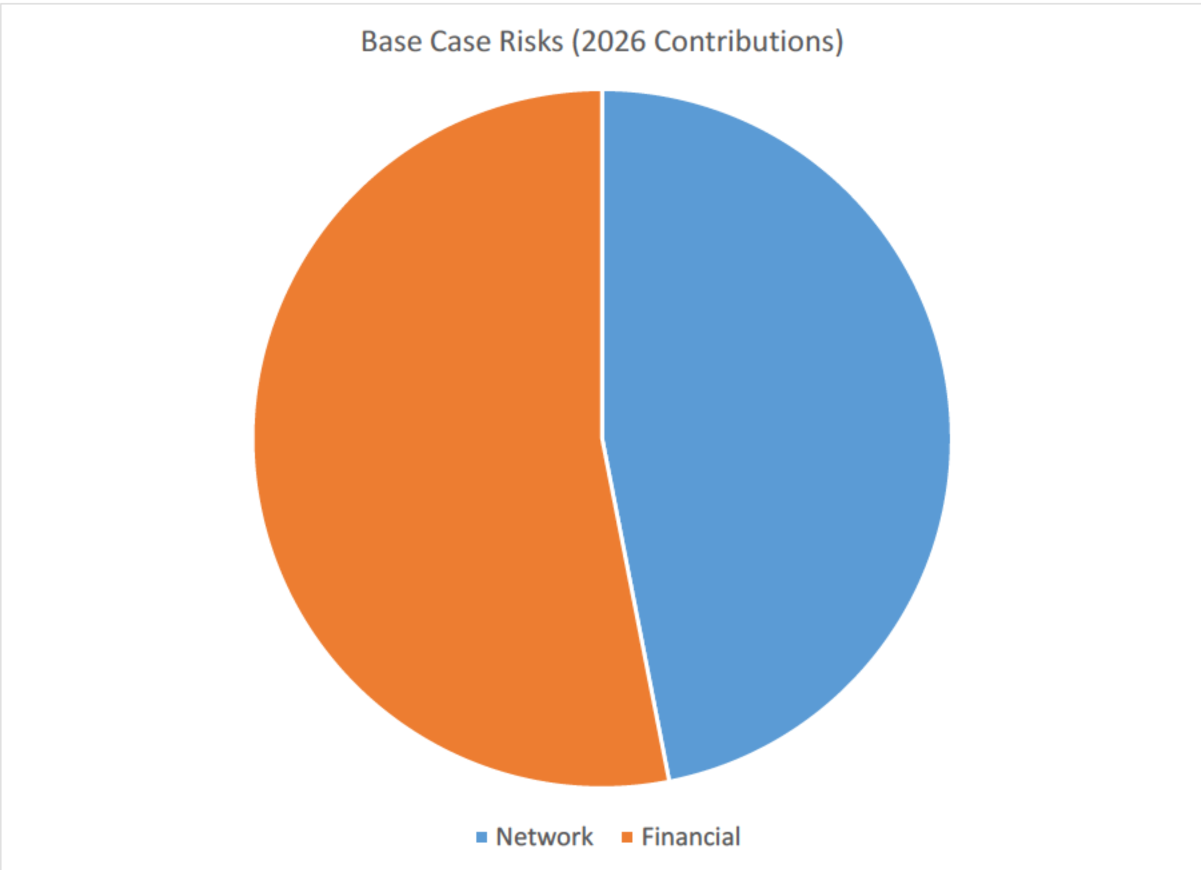


Figure 4 – Middle Ridge 2026 risk cost by category

3.4 Base case risk statement

The main base case risks for the secondary systems at Middle Ridge substation are associated with financial risks to replace the failed secondary systems in an unplanned (emergency) manner, and network risks (unserved energy) resulting from concurrent network outages associated with equipment failures.

4 Participation factors

A sensitivity analysis was carried out to determine the participation factors for key inputs to the risk cost models (i.e. to identify which inputs are most sensitive to overall risk cost).

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 following figures.

As an example, the participation of VCR to risk cost post obsolescence is approximately 56.6%. Hence, an increase in VCR of 100% would increase the overall risk cost by around 56.6%.

Due to the non-linear nature of the risk cost model (specifically network risk costs which are a function of concurrent failures), the participation factor can change depending on the magnitude of input percentage change. The participation factors calculated below are based on an increase of input by 100%.

The following observations can be made:

- Pre-secondary systems obsolescence: the model is most sensitive to emergency replacement cost followed by plant restoration time.
- Post-secondary systems obsolescence: the model is most sensitive to plant restoration time followed by VCR.

Table 2: Input values, secondary systems model

	Item	Value	Unit
Network	VCR	33,045	$/MWh
	Plant restoration time with spares	1	Day
	Plant restoration time with no spares	7	Days
Financial	Emergency replacement cost with spares	0.01	$million
	Emergency replacement cost with no spares	0.1	$million

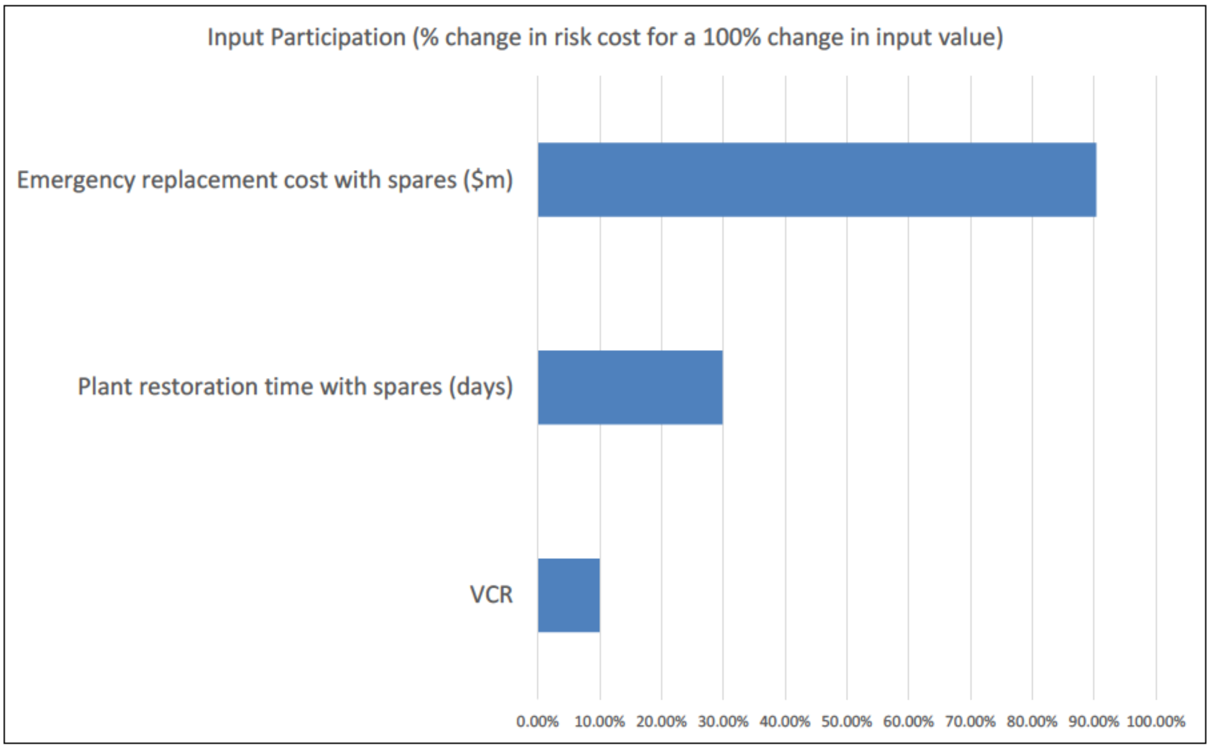


Figure 5 - Participation factors, secondary systems model – pre secondary systems obsolescence

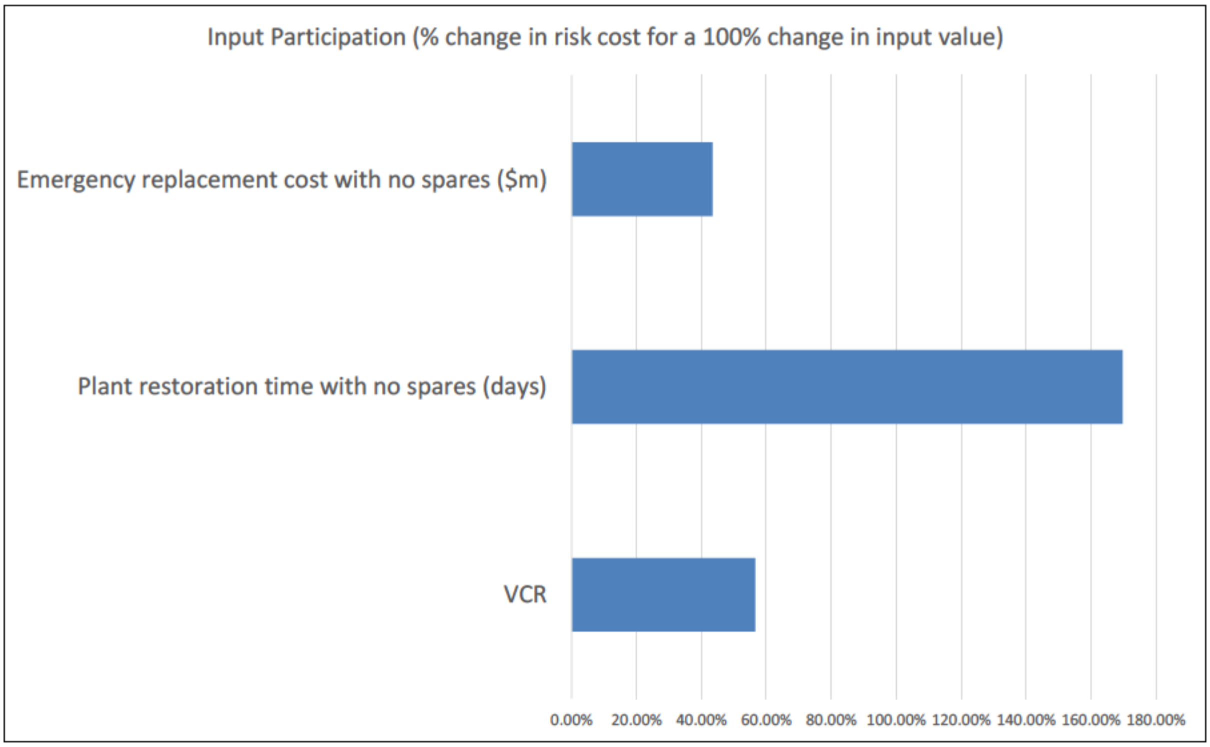


Figure 6 - Participation factors, secondary systems model – post secondary systems obsolescence

Project Scope Report

CP.02760

Middle Ridge Secondary Systems Replacement

Concept – Version 1

Document Control

Change Record

Issue Date	Responsible Person	Objective Document Name	Background
31/01/20	[redacted]	Project Scope Report CP.02760 Middle Ridge Secondary Systems Replacement	Preliminary scope

Related Documents

Issue Date	Responsible Person	Objective Document Name
28/03/2019	[redacted]	H014 Middle Ridge Secondary Systems Condition Assessment Report March 2019

Project Contacts

Project Sponsor	[redacted]	[redacted]
Connection & Development Manager	<name>	Ext.
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Project Manager	<name>	Ext.
Design Coordinator	<name>	Ext.
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Project Details

1. Project Need & Objective

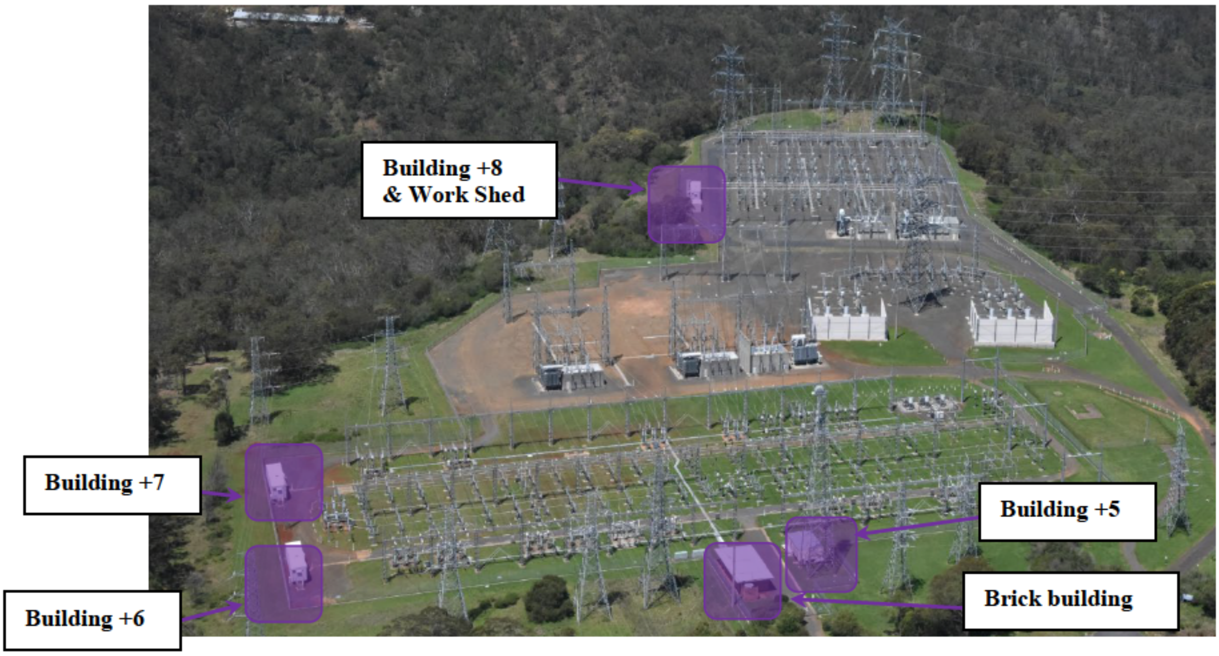
H014 Middle Ridge is a 330/275/110kV transmission substation in the wider interconnected network supplying power to Southern Queensland. The majority of the secondary systems were commissioned from 2002 to 2007, while the secondary systems for the 330kV capacitor banks were commissioned in 2011. The Middle Ridge substation is a major transmission node as well as an essential bulk supply point for Ergon Energy and Energex.

The objective of this project is to replace the secondary systems at H014 Middle Ridge by 31st October 2025.

2. Project Drawing

[redacted]

H014 Middle Ridge operating diagram



Middle Ridge substation yard bird view

3. Project Scope

3.1. Original Scope

The following scope presents a functional overview of the desired outcomes of the project. The proposed solution presented in the estimate must be developed with reference to the remaining sections of this Project Scope Report, in particular *Section 5 Special Considerations*.

Briefly, the project consists of replacement of the 330kV, 275kV and 110kV secondary systems equipment at H014 Middle Ridge substation.

3.1.1. Transmission Line Works

Nil

3.1.2. H014 Middle Ridge Substation Works

Design, procure, construct and commission the following works.

- One (1) new 275kV control building for a staged cutover of secondary systems panels from the existing +8 building.

- Two (2) new 132kV control buildings for a staged cutover of secondary systems panels from the existing +6 and +7 buildings.

- Replace all secondary systems and associated protection into the new control buildings for the following bays:

  - 330kV Feeder 9907 & 9908
  - 330kV/275kV transformers 4T & 5T
  - 330kV 3 & 4 Cap
  - 275kV 1 and 2 bus
  - 275kV bus coupler 501, 502, 503 & 504
  - 275/110 kV transformers 1T, 2T and 3T
  - 275kV Feeder 831, 8848, 8849
  - 110kV 1, 2 and 3 bus
  - 110kV bus coupler 401, 402 and 411
  - 110kV Feeder 711 (Bay Spare 5), 7233, 7234, 727, 731, 732, 733, 735, 7348, 728, 730, 734 and 736
  - 110kV 1 and 2 Cap

- Associated switchyard civil works including new cable trenches and cable termination kiosks as appropriate.

- Replace marshalling cubicle for 275/110kV transformers 2T and 3T 110kV and associated control cables.

- Replace the physical disconnect terminals of CT circuits on marshalling kiosks including:

  - 330kV 3 & 4 Cap
  - =KC1 and =KC2 - 275kV bus zones
  - Diameter =C1 – 275kV coupler 501, 2 Transformer and 3 Transformer
  - Diameter C2 – 275kV coupler 502, 1 Transformer and Feeder 831
  - Diameter =C3 - 275kV coupler 503, 4 Transformer and Feeder 8848
  - Diameter =C4 – 275kV coupler 504, 5 Transformer and Feeder 8849
  - =KD1, =KD2 and =KD3 = 110kV bus zones
  - 110kV bus coupler 401, 402 and 403
  - 110kV 1 Transformer
  - 110kV Feeder 711 (Bay Spare 5), 7233, 7234, 727, 731, 732, 733, 735, 728, 730, 734, 736 (except Feeder 7348)

- Replace all SCADA RTU for 330kV, 275KV and 110kV and upgrade the DNP serial to DNP over IP.

- Replace all Comms and common RTU in buildings +5, +6, +7 and +8.

- Replace timing clocks for Buildings +6, +7 and +8.

- Replace all OpsWAN equipment (including all OpsWAN cameras) in the brick building, +5, +6, +7 and +8.

- Replace all 125VDC battery banks and chargers in Building +6, +7 and +8.

- Replace 48VDC battery banks.

- Replace Blade 150 HMI Sun Workstation.

- Replace energy metering equipment for Feeder 727, 7234, 728, 733, 736, 7233, 730, 734, 735 and 7348 and migrate to IP based metering.

- Replace the existing traveling wave based fault locator for feeder 9907 and 9908 with an approved new unit such as SEL-T400L.

- Replace UP-2210 power quality monitoring and IDM+ high speed monitoring.

- Replace GIC monitoring based on traditional DC transducers.

- Replace GIC monitoring electronic devices based on flexible Optical CT.

- Recovered +6, +7 and +8 buildings are to be assessed and if suitable for future projects, returned to the appropriate location. If not suitable should be sold and recovered budget used to offset project costs.

- Update SAP, CMS and drawings in SPF accordingly.

3.1.3. Substation Works – Remote Ends

Minimal works are planned for the remote ends. The scope is limited to minor works including adjustment to CT ratios and protection settings consequential to the replacement of secondary systems in the selected bays at Middle Ridge.

3.1.4. Telecoms Works

Not applicable

3.1.5. Easement/Land Acquisition & Permits Works

Not applicable

4. Project Timing

4.1. Project Approval Date

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

4.2. Site Access Date

H014 Middle Ridge is an existing Powerlink operational substation and access to the site is immediately available.

4.3. Commissioning Date

The latest date for the commissioning of the new assets included in this scope and the decommissioning and removal of redundant assets, where applicable, is 31 October 2025.

5. Special Considerations

Not applicable

6. Asset Management Requirements

Equipment shall be in accordance with Powerlink equipment strategies.

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

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

7. Asset Ownership

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

8. System Operation Issues

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

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

9. Options

Not applicable

10. Division of Responsibilities

A division of responsibilities document will be required to cover the changes to the interface boundaries with Energy Queensland. The Project Manager will be required to draft the document and consult with the Project Sponsor who will arrange sign-off between Powerlink and the relevant customer.

11. Related Projects

No related projects.

Concept Estimate for CP.02760 - Middle Ridge Secondary Systems Replacement

Record ID	A3307254	
Policy stream	Asset Management	
Authored by	Project Manager	[redacted]
Reviewed by	Team leader projects	[redacted]
Approved by	Manager Projects	[redacted]

Table of Contents

1. Executive Summary

H014 Middle Ridge is a 330/275/110kV transmission substation in the wider interconnected network supplying power to Southern Queensland on the South Eastern Side of Toowoomba, on the edge of the range.

This substation is a major transmission node as well as an essential bulk supply point for Ergon Energy and Energex.

The majority of the secondary systems were commissioned from 2002 to 2007, while the secondary systems for the 330kV capacitor banks were commissioned in 2011.

Briefly, the project consists of replacement of the 330kV, 275kV and 110kV secondary systems equipment at H014 Middle Ridge Substation.

Given the size of the project and required coordinated staging of construction and commissioning activities, it is expected that this project being completed by 2030, if the project being approved by January 2023.

1.1 Project Estimate

Estimate Components		Base $	Escalated $
Estimate Class	5		
Estimate Accuracy	+100% / -50%		
Base Estimate		**38,503,749**	**50,270,450**
Mitigated Risk	[redacted]	[redacted]	[redacted]
Contingency Allowance	[redacted]	[redacted]	[redacted]
TOTAL		[redacted]	[redacted]

1.2 Project Financial Year Cash Flows

	June 2020 Base $	Escalated $
To June 2023	5,775,562	7,540,567
To June 2024	11,551,125	15,081,135
To June 2025	7,700,750	10,054,090
To June 2026	5,775,562	7,540,567
To June 2027	3,080,300	4,021,636
To June 2028	2,310,225	3,016,227
To June 2029	1,540,150	2,010,818
To June 2030	770,075	1,005,409
TOTAL	**38,503,749**	**50,270,450**

2. Project and Site Specific Information

2.1 Project Dependencies & Interactions

Project No.	Project Description	Planned Commissioning Date	Comment
Dependencies			
Interactions			
OR.XXXX	Middle Ridge No 2 and No.3 275/110kV Transformer Refurbishment	2025	
OR.XXXX	Middle Ridge Substation Primary Plant Refurbishment	2026	
Other Related Projects			

3. Full Replacement of Secondary System at H014 Middle Ridge Substation

3.1 Definition

3.1.1 Scope

The project consists of complete replacement of the 330kV, 275kV and 110kV secondary system equipment in three new demountable buildings at H014 Middle Ridge Substation.

Substation Single Line Diagram and Photo:

[redacted]

Figure 3-1 -H014 Middle Ridge operating diagram

Figure 3-2 - Middle Ridge Substation yard bird view

3.1.1.1 Substations Works

Substation Works include the Design, procurement, construction and commissioning of the following works:

- One (1) new 275kV control building for a staged cutover of secondary systems panels from the existing +8 building.
- Two (2) new 110kV Control buildings for a staged cutover of secondary systems panels from the existing +6 and +7 buildings.
- Replace all secondary systems and associated protection into the new control buildings for the following bays:
    - 330kV Feeder 9907 & 9908
    - 330kV/275kV transformers 4T & 5T
    - 330kV 3 & 4 Cap
    - 275kV 1 and 2 bus
    - 275kV bus coupler 501, 502, 503 & 504
    - 275/110 kV transformers 1T, 2T and 3T
    - 275kV Feeder 831, 8848, 8849
    - 110kV 1, 2 and 3 bus
    - 110kV bus coupler 401, 402 and 411
    - 110kV Feeder 711 (Bay Spare 5), 7233, 7234, 727, 731, 732, 733, 735, 7348, 728, 730, 734 and 736
    - 110kV 1 and 2 Cap
- Associated switchyard civil works including new cable trenches and cable termination kiosks as appropriate.
- Replace marshalling cubicle for 275/110kV transformers 2T and 3T 110kV and associated control cables.

- Replace the physical disconnect terminals of CT circuits on marshalling kiosks including:
  - 330kV 3 & 4 Cap
  - =KC1 and =KC2 - 275kV bus zones
  - Diameter =C1 – 275kV coupler 501, 2 Transformer and 3 Transformer
  - Diameter C2 – 275kV coupler 502, 1 Transformer and Feeder 831
  - Diameter =C3 - 275kV coupler 503, 4 Transformer and Feeder 8848
  - Diameter =C4 – 275kV coupler 504, 5 Transformer and Feeder 8849
  - =KD1, =KD2 and =KD3 = 110kV bus zones
  - 110kV bus coupler 401, 402 and 403
  - 110kV 1 Transformer
  - 110kV Feeder 711 (Bay Spare 5), 7233, 7234, 727, 731, 732, 733, 735, 728, 730, 734, 736 (except Feeder 7348)
- Replace all SCADA RTU for 330kV, 275KV and 110kV and upgrade the DNP serial to DNP over IP.
- Replace all Comms and common RTU.
- Replace timing clocks.
- Replace all OpsWAN equipment (including all OpsWAN cameras).
- Replace all 125VDC battery banks and chargers
- Replace 48VDC battery banks.
- Replace Blade 150 HMI Sun Workstation.
- Replace energy metering equipment for Feeder 727, 7234, 728, 733, 736, 7233, 730, 734, 735 and 7348 and migrate to IP based metering.
- Replace the existing traveling wave based fault locator for feeder 9907 and 9908 with an approved new unit such as SEL-T400L.
- Replace UP-2210 power quality monitoring and IDM+ high speed monitoring.
- Replace GIC monitoring based on traditional DC transducers.
- Replace GIC monitoring electronic devices based on flexible Optical CT.
- Update SAP, CMS and drawings in SPF accordingly.
- Remote Ends :

Minimal works are planned for the remote ends. The scope is limited to minor works including adjustment to CT ratios and protection settings consequential to the replacement of secondary systems in the selected bays at Middle Ridge.

3.1.1.2 Transmission Line Works

Not applicable

3.1.1.3 Telecommunication Works

Telecommunication system should be upgraded as required.

3.1.1.4 Easement/Land Acquisition & Permit Works

Not applicable

3.1.2 Major Scope Assumptions

- It is assumed that anticipated date for project approval is end of January 2023.
- It is assumed that the outages will be available as required. No Live Sub/Live lines are required. Return to service times have been assumed as >2 days for all network elements except for 731, 731, 735 and 736.
- It is assumed that the new cables will be required and will be included in the design.
- It is assumed that the existing bay marshalling kiosks will be reused and that CT terminals/links will be replaced.
- It is assumed that no new AC and DC kiosk will be required.
- It is assumed that the new buildings will be located within the vicinity of the existing buildings and field termination racks can be utilised.
- It is assumed that the construction of limited new trenching will be required only to the new building locations.
- It is assumed that the new foundation will include the provision of bored piers and the estimates include the sufficient costs for geo-tech.
- It is assumed that the new relays considered for the upgrade of the remote sites will be suitable for the customer's needs and requirements.
- For each Ergon/Energex remote end, works will be required to interface with Powerlink's protection. It is assumed these costs will be borne by Ergon/Energex

3.1.3 Scope Exclusions

- This estimate does not include any costs for repairing or modification to the primary plants.
- No upgrade to the earth grid is included in this estimate.
- No Expansion to the switchyard is considered in this estimate.
- This scope does not include any upgrade to the existing internal roads.
- This scope does not include any upgrade to the existing lighting.
- This scope does not include any upgrade to the existing fencing and gates.
- This scope does not modify the existing brick buildings and amenities.
- No asbestos removal is included in the scope of this project.
- No modification on the existing transmission lines are considered in this estimate.

3.2 Project Execution

3.2.1 Project Schedule

A High Level Project Schedule has been developed as per below:

Task	Target Completion
Project Approval, PAN Issued	January 2023
Site Access Date	January 2024
Construction	January 2024 to December 2024
Commissioning (110kV)	January 2025 to October 2026
Commissioning (275/330kV)	January 2027 to October 2029
Final Decommissioning	June 2030
Project Completion	June 2030

Note: In case of finding an opportunity to partially overlap 110kV and 275kV commissioning, there will be opportunities to reduce project time frame in order to complete delivery by June 2029.

3.2.2 Network Impacts

The work will have significant impact on the operation of the network due to the large number of outages that will be required for cutting into the new secondary system.

Outages have been negotiated with Net Ops and a very high level outage plan backed by staging plan has been developed and included in this concept estimate.

3.2.3 Project Staging

Stage	Description/Tasks
	110kV/275kV/330kV FAT
	110kV cable installation 110kV Site Prep and PSI
	110kV Sec Sys Cut over
	Decommission/Remove redundant 110kV equipment
	275kV & 330KV cable installation 275kV & 330KV Site Prep and PSI
	275KV Secsys cut over
	Decommission/Remove redundant 275/330kV equipment

3.2.4 Resourcing

It is assumed that the **design** of the project will be performed at Powerlink.

Contractor will perform civil works, cable laying, building installation and energization, panel termination.

Powerlink MSP will be engaged to perform switching operations, FAT, SAT, commissioning, removal of the old sec sys and cables.

3.3 Project Estimate

Estimate Components		Base $	Escalated $
Estimate Class	5		
Estimate Accuracy	+100% / -50%		
Base Estimate		**38,503,749**	**50,270,450**
Mitigated Risk	[redacted]	[redacted]	[redacted]
Contingency Allowance	[redacted]	[redacted]	[redacted]
TOTAL		[redacted]	[redacted]

3.4 Project Financial Year Cash Flows

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To June 2027	3,080,300	4,021,636
To June 2028	2,310,225	3,016,227
To June 2029	1,540,150	2,010,818
To June 2030	770,075	1,005,410
Total	**38,503,749**	**50,270,450**

3.5 Project Asset Classification

Asset Class	Asset Life	Base $	Percentage
Secondary systems	15 years	30,012,205	78%
Communications	15 years	1,694,023	4%
Transmission line refit	35 Years		
Primary plant	40 years	6,797,521	18%
Transmission lines	50 years		
TOTAL		**38,503,749**	

4. References

Document name	Version	Date
Project Scope Report	1.0	31/01/2020