2023-27
POWERLINK QUEENSLAND REVENUE PROPOSAL

Project Pack – PUBLIC

CP.02751
Murarrie Secondary Systems Replacement

CP.02751 – Murarrie Secondary System Replacement

Project Status: Not Approved

1. Network Requirement

The 275/110kV Murarrie Substation, approx. 8km from the Brisbane CBD, was established in 2003 provides an injection point to the Powerlink and Energy Queensland eastern 110kV sub-transmission ring. This network supplies residential, industrial and commercial loads within the Brisbane area including the eastern Brisbane suburbs, eastern ring of Brisbane CBD, Port of Brisbane and TradeCoast area. An outage of this asset would put up to 115MW of power and up to 885MWh of energy per day at risk[2].

A Condition Assessment (CA) carried out in December 2018 identified that most secondary system assets will reach the end of their technical service lives between 2024 and 2027[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 Australian Energy Market Operator's (AEMO's) Power System Security Guidelines (V95, 2019).

Energy Queensland's forecasts confirm there is an enduring need to maintain electricity supply to industrial, commercial and residential loads supplied from Murarrie 275/110kV substation, including the Brisbane eastern suburbs, eastern ring of Brisbane CBD, Port of Brisbane and TradeCoast area. The removal or reconfiguration of the Murarrie Substation due to secondary system failure or obsolescence would violate Powerlink's Transmission Authority reliability obligations (N-1-50MW / maximum 600MWh unserved energy). Failure to address the obsolescence of this asset is likely to result in non-compliance with Powerlink's reliability and system security obligations[6].

2. Recommended Option

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

The current recommended option is to replace all 275kV and 132kV secondary systems at Murarrie Substation by 2027[2].

The following options were considered but not proposed:

- Do Nothing – rejected due to non-compliance with reliability standards.
- Reinforcement of Belmont substation and associated 110kV system – not considered commercially feasible due to the significantly higher cost compared to the secondary systems works proposed for Murarrie substation.
- Establishment of Cross River 110kV ring from South Pine substation – not considered commercially feasible due to the significantly higher cost.
- Installation of Battery Energy Storage System (BESS) at Murarrie substation– not considered commercially feasible due to the significantly higher cost.
- Non-Network Option parameters identified – at present no viable non-network option has been identified.

Figure 2-1 shows the current recommended option reduces the forecast risk monetisation profile of the Murarrie Substation secondary systems to approx. $10k per annum. 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 reaches over $300k per annum in 2030 and continues to rise each year thereafter. The significant increase in risk cost in 2024 coincides with the depletion of available spares, which result in financial risks to replace the failed secondary systems in an unplanned (emergency) manner and network risks (unserved energy) from concurrent network outages due to equipment failures.[3]

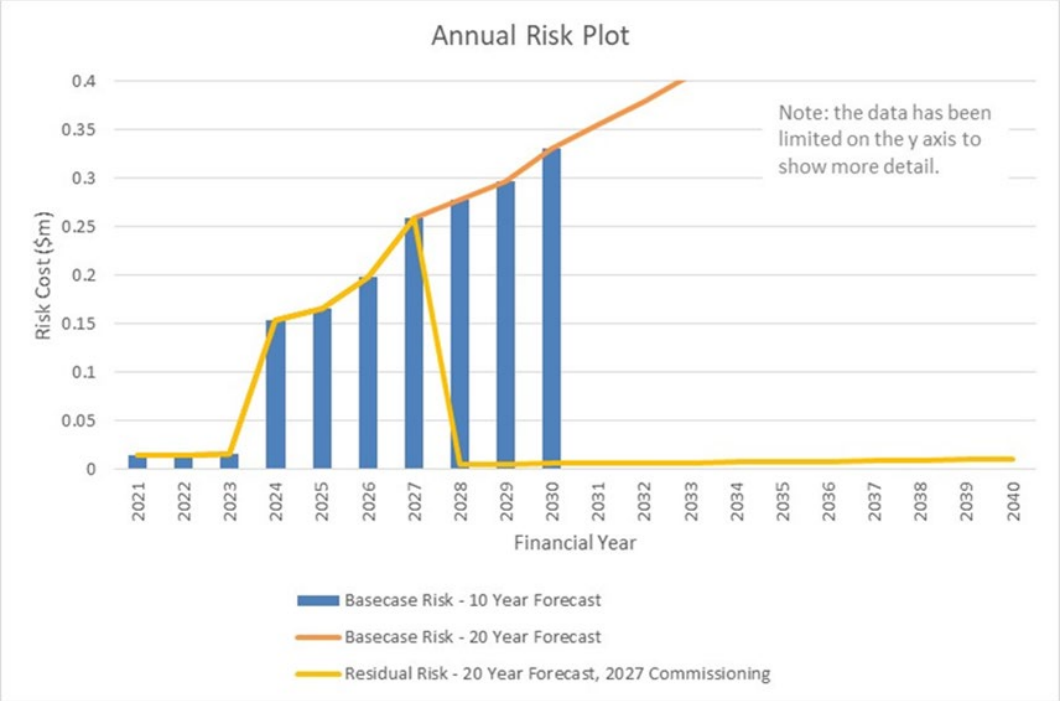

Figure 2-1 Annual Risk Monetisation Profile (Nominal)

3. Cost and Timing

The estimated cost to replace the 275/110kV secondary systems at Murarrie Substation is $16.5m ($2019/20 Base)[5].

Target Commissioning Date: June 2027

4. Documents in CP.02751 Project Pack

Public Documents

1. Secondary Systems Condition Assessment Report – H021 Murarrie 275kV, 110kV Substation
2. CP.02751– H021 Murarrie Secondary Systems Replacement – Planning Statement
3. Base Case Risk and Maintenance Costs Summary Report CP.02751 H021 Murarrie Secondary Systems Replacement
4. Project Scope Report CP.02751 Murarrie Secondary System Replacement
5. CP.02751 – Murarrie Secondary System Replacement - Project Management Plan

Supporting Documents

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

H021 Murarrie
275kV, 110kV Substation

Secondary Systems Condition Assessment Report

Document Details			
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Date	Version	Nature of Change	Author	Authorisation
06/12/2018	1.0	Final	[redacted]	[redacted]

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1. Introduction

H021 Murarrie substation is a major 275 and 110kV substation, approximately 8km from the Brisbane CBD. The substation consists of both 275kV and 110kV bays sharing a common platform and a perimeter fence. The substation was established in 2003 and later extended to accommodate the Network Development in the Metropolitan Area.

This report is pertinent to H021 Murarrie 275kV / 110kV substation secondary systems. Recommendations in this report have been based on the conditions of secondary system assets only. Network reconfigurations, refurbishment solutions and implementation methodologies have not been considered in this report. These factors should be covered by the relevant stakeholders.

H021 Murarrie 275 / 110kV substation currently consists of:

- A 275 / 110 kV substation;
- Two (2) of 275 / 110kV Transformers;
- 17 of 275kV and 110kV bays:
    - 2 x 275/110kV Transformer Ended Feeder Bays – (T2 HV and T3 HV):
        - = C01, Transformer Ended Feeder 830 (H003 – Belmont)
        - = C02, Transformer Ended Feeder 8837 (H003 – Belmont)
    - 9 x 110kV Feeder Switching Bays:
        - =D02-A10, Feeder 753 (Newstead)
        - =D05-A10, Feeder 752 (Newstead)
        - =D06-A10, Feeder 7288 (Belmont Tee Wellington Road)
        - =D09-A10, Feeder 7287 (Belmont Tee Wellington Road)
        - =D10-A10, Feeder 7274 (Doboy)
        - =D13-A10, Feeder 7273 (Doboy)
        - =D27-A10, Feeder 7272 (Doboy)
        - =D30-A10, Feeder 7270 (Lytton)
        - =D33-A10, Feeder 7271 (Lytton)
    - 2 x 110kV Transformer Switching Bays:
        - =D19-A10, T2 LV (CB 4422)
        - =D25-A10, T3 LV (CB 4432)
    - 2 x 110kV Bus Sections Switching Bays:
        - =D01-A10, 1 and 2 Bus Section (CB 4112)
        - =D21-A10, 2 and 3 Bus Section (CB 4122)
    - 2 x 110kV Capacitor Bank Switching Bays:
        - =D16-A10, Capacitor Bank #2 (CB 4822)
        - =D23-A10, Capacitor Bank #3 (CB 4832)

Figure 1 - H021 Murarrie 275/110kV Substation Aerial View

2. Site infrastructure

2.1 Substation Buildings

There are five (5) buildings at H021 Murarrie substation:

- Building “+T” (Brick building): Telecommunications, site OpsWAN server, AC and DC systems, workshop and amenities.
- Demountable Building “+5”: 275kV secondary systems, AC and DC systems.
- Demountable Building “+A”: 110kV (Bus 1) secondary systems, AC and DC systems.
- Demountable Building “+B”: 110kV (Bus 2) secondary systems, AC and DC systems.
- Demountable Building “+C”: 110kV (Bus 3) secondary systems, AC and DC systems.

Building +5 has space to accommodate another thirteen (13) standard secondary system panels, refer to drawing series A1-H-127436.

Building +A has space to accommodate another fourteen (14) standard secondary system panels, refer to drawing series A1-H-120620.

Building +B has space to accommodate approximately another five (5) standard secondary system panels, refer to drawing series A1-H-120621.

Building +C has space to accommodate another four (4) standard secondary system panels, refer to drawing series A1-H-120622.

All control buildings and communications rooms are air-conditioned, except the workshop, lunch room and amenity room of the building “+T”.

Figure 2 - H021 Murarrie Brick Building “+T”

Figure 3 - H021 Murarrie 275kV Demountable Building “+5”

Figure 4 - H021 Murarrie 110kV Demountable Building “+A”

Figure 5 - H021 Murarrie 110kV Demountable Building “+B”

Figure 6 - H021 Murarrie 110kV Demountable Building “+C”

The condition assessment of the buildings is not in scope of this report; please refer to the relevant substation condition assessment report. Based on visual inspection, the existing control buildings appear to be in serviceable condition. Depending on the secondary systems implementation methodology and the availability of spare panel spaces, existing control buildings can be utilised to accommodate new secondary systems.

3. Condition Assessment

3.1 Cable Trenches, HV Yard Control Cables and Marshalling Cubicles

The majority of control and protection cables were terminated directly between secondary systems panels and PASS-M0 switchgear control cubicles. These are integral parts of the primary plant hence their conditions are not covered in this report. In general, PASS-M0 switching bays don't have dedicated bay marshalling kiosks.

Conditions of other bay marshalling kiosks e.g. AC, DC, bus zone CTs and VT kiosks, including internal links, terminals, wirings, MCBs / fuses and cables to primary plant were visually inspected and assessed. Equipment Health Indices and recommended replacement timeframe have been detailed in the **Appendix A (Substation)**.

3.1.1 Cable Trenches

Cable trenches and substation structures are classed as HV systems assets. Condition assessments of these assets have been excluded from this report. The following photos were taken during the site inspection in August 2018 are for information purposes only.

Figure 7 - Murarrie 110kV Cable Trenches

3.1.2 HV Yard Cables

Visual inspections of cables between control buildings and yard marshalling kiosks / PASS-M0 control cubicles showed that most cables are still in fair condition and considered to be suitable for another 20-25 years of service. Cables between yard marshalling kiosks and PASS-M0 switchgear control cubicles, as well as other HV primary plant are also in fair condition. These cables should be replaced at the same time with the primary plant replacement.

3.1.3 Marshalling Cubicles

There is no conventional switching bay marshalling cubicle at this site. The PASS-M0 control cubicles serve both as the switching bay marshalling cubicles and switchgear control cubicles. The chassis of marshalling cubicles, including VT, AC and DC, are in fair condition and deemed to be suitable for another 20-25 years of service. However, door seals and air filters of some kiosks may have been degraded due to poor quality materials that have been subjected to UV light, heat and air pollution. All yard cables are not required to be replaced therefore marshalling cubicles can also be retained as is and only new door seals, air filter, which are recommended to be replaced every five / six years as part of routine maintenance.

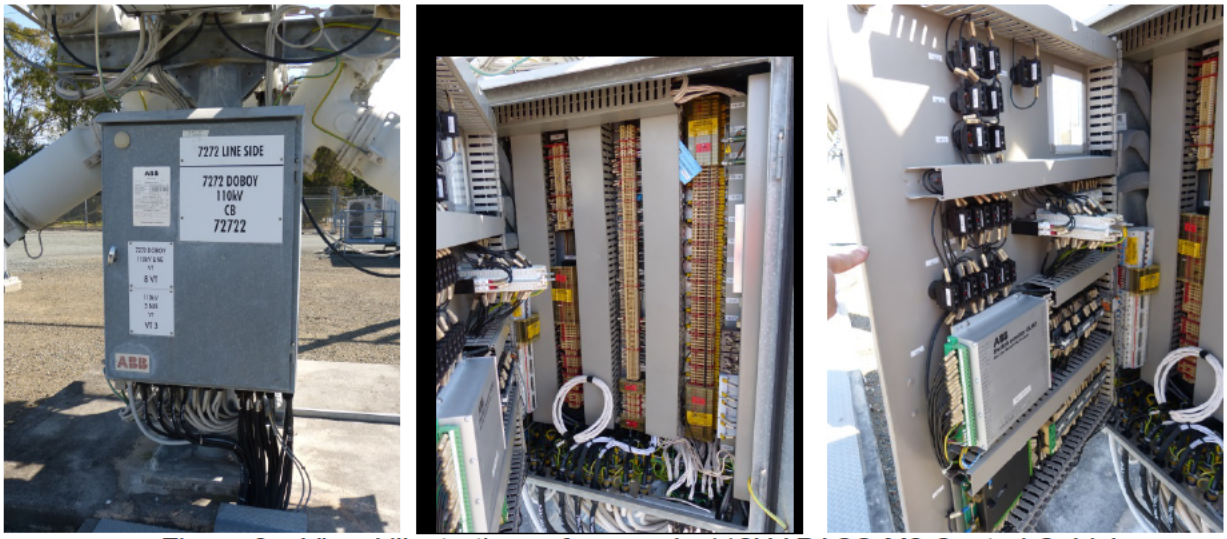


Figure 8 – Visual illustrations of a sample 110kV PASS-M0 Control Cubicle

Figure 9 – Visual illustrations of a sample 110kV Conventional VT Kiosk

3.2 Termination Racks, Bay and Non-Bay Control and Protection Equipment

Condition assessments of H021 Murarrie substation 110 and 275kV control and protection systems, including cubicles, equipment, internal components such as links, terminals, wirings, MCBs, fuses, cables are summarised in the **Appendix A (Substation)**.

3.2.1 Building Termination Racks

All demountable control buildings e.g. +5, +A, +B, +C have termination racks.

3.2.2 Secondary Systems Panels

All secondary systems panels, including auxiliary parts e.g. links, terminals and internal wirings are still in good condition and don't need to be replaced unless Powerlink's standard secondary systems solutions dictate their replacement.

Visual illustrations of the existing secondary systems panels are shown below.

+A5 - Bay =D10 - Feeder 7274 Doboy 2003

+5A4 - 275kV Bay =C02 - Fdr 8837 2008

Figure 10 - Murarrie 110kV and 275kV Secondary Systems

3.2.3 Control, Protection, Auxiliary, Ancillary, Metering and OpsWAN Equipment

3.2.3.1. Assessment Methodologies based on Risk, Cost and Performance

Health indices of secondary systems equipment have been assessed in accordance with Powerlink Quantitative Risk Assessment Frameworks and the Secondary Systems Asset Risk Model developed in [1] based on the following parameters:

- Equipment functional failure rates,
- Environmental conditions where equipment are installed,
- Equipment ages,

Equipment condition, as represented by health indices, is a fundamental input of the secondary systems **reliability**. Fundamental inputs of the secondary systems **availability** are derived from the availability of suitable spare parts, equipment obsolescence and technical support (hardware, software and firmware). The **capability** (i.e. **performance**) of the secondary systems depends on both the systems reliability and availability.

Health indices are modelled in the range from zero (0) to ten (10), where zero represents newly installed assets and ten indicates assets that have reached end of their technical service life. Assets with a health index close to ten represent moderate increase of functional failures, but longer outage duration and significantly higher risk of impacting system's availability and reliability due to the lack of manufacturer support and available spares.

The recommended replacement timing for secondary systems assets has been based on the secondary systems capability, associated network risks and cost. This report recommends the replacement timing for secondary systems assets and equipment based on the above principles and condition assessment data. It does not specify any specific requirements for replacement methodologies or solutions. A cost effective solution that satisfies Powerlink's requirements will be required to address the conditions of assets listed in the Appendix A.

Depending on fundamental inputs and systems performance, the replacement timing is also recommended for groups of secondary systems assets with lower health indices (e.g. acceptable reliability) but lack of spares and technical support (e.g. low availability). These assets can often be grouped together based on their reliability and availability for strategic and opportunistic replacement in order to maximise cost benefits and asset lifecycle management benefits.

3.2.3.2. 275kV and 110kV Substation Secondary Systems Assets Conditions

Murarrie 275 and 110kV secondary systems comprise mostly digital (microprocessor type) protection and control equipment manufactured approximately between 2001 and 2018. There is a small number of modern electro-mechanical relays still being used for high impedance protection e.g. bus zone and reactor MFAC protection relays. It's important to note that there are some relatively new relays that may have been replaced as part of remote end protection upgrade and faulty relay replacement during operation.

A number of equipment models have been phased out or superseded by the newer models. It means that like-for-like equipment replacement may not be practically possible for some models.

Upgrade to newer models is always possible as long as it is carried out under appropriately planned secondary systems outages e.g. planned secondary systems refurbishment projects.

Figure 11 - Murarrie 275kV and 110kV – Typical Substation Secondary Systems Equipment

OpsWAN systems and equipment at this site were installed at various stages since 2003. OpsWAN systems are still functioning and have an important role in operation and maintenance efficiencies. They are considered as auxiliary sub-systems of the power systems. Generally, their condition and performance do not trigger secondary systems replacement projects. Therefore, OpsWAN systems and equipment should be replaced as part of a major secondary systems replacement project.

275kV Building +5 | 110kV Building +A | 110kV Building +B | 110kV Building +C

Figure 12 - Murarrie 275kV & 110kV Substation OpsWAN Systems and Equipment

3.2.4 Auxiliary Supply

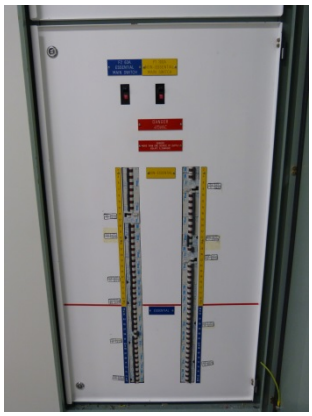
3.2.4.1. AC Auxiliary Supply

AC auxiliary supplies, including station transformers and backup diesel generator/s are classed as HV primary systems assets. Condition assessments of HV primary systems assets have been excluded from this report. The following notes were recorded and visually illustrated for information purposes only.

The 400/230 VAC changeover cubicle inside the building +T (brick building) was installed in November 2002. Each control building has a dedicated building AC distribution board.

Diesel Generators


AC Changeover


275kV building +5


110kV building +A


110kV building +B


110kV building +C

Figure 13 - Murarrie 275kV and 110kV AC Supply, Changeover and AC Distribution

3.2.4.2. DC Batteries and Chargers

The brick building +T (telecoms and OpsWAN building) has duplicated A & B 50V DC batteries and chargers only - no 125V DC batteries and chargers.

All demountable buildings, e.g. +5, +A, +B, +C have duplicated X & Y 125VDC secondary systems batteries and chargers, but no 48V DC batteries and chargers. Telecommunications equipment e.g. Muxes in these buildings are supplied from 125 / 48V DC/DC converters.

- 110kV demountable building +A – X and Y 125V DC batteries and chargers:
  - Batteries: 2017
  - Battery charger and monitoring system: 2009

- 110kV demountable building +B – X and Y 125V DC batteries and chargers:
  - Batteries: 2017.
  - Battery charger and monitoring system: 2009

- 110kV demountable building +C – X and Y 125V DC batteries and chargers:
  - Batteries: 2017.
  - Battery charger and monitoring system: 2009

- 275kV demountable building +5 – X and Y 125V DC batteries and chargers:
  - Batteries: 2006.
  - Battery charger and monitoring system: 2009

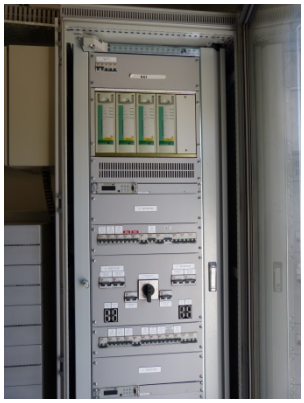
- Telecoms and OpsWAN brick building +T – A and B 50V DC batteries and chargers:
  - Batteries: 2016.
  - Battery charger and monitoring system: 2009

The replacement of batteries and chargers in building +5 (275kV building) has already been included in OR 01650 project.


Building +A – 125VDC Batteries and Chargers

Building +B – 125VDC Batteries and Chargers


Building +C - 125VDC Batteries and Chargers

Building +5 - 125VDC Batteries and Chargers


Building +T - 50VDC Batteries and Chargers

Figure 14 - Murarrie 275kV and 110kV DC Batteries and Chargers

4. Conclusion

This report details the conditions of secondary systems assets at Murarrie 275kV, 110kV Substation. Equipment health indices and replacement timeframe have been recommended in the Appendix A. The primary objective of the recommended secondary systems refurbishment project is to maintain the current network reliability and availability and to minimise operation and compliance risks associated with secondary systems assets at Murarrie substation.

5. Attachments

- **Appendix A** – H021 Murarrie 275KV & 110KV Substation Secondary Systems Equipment Health Indices and Recommended Replacement Timeframe.

6. References

[1] "Modelling Substation control and Protection Asset Condition for Optimal reinvestment Decision Based on Risk, Cost and Performance", CIGRE PARIS 26-31 August 2018, T Vu, M. Pelevin, D. Gibbs, J.Horan, C. Zhang.

7. Appendix A

APPENDIX A - H021 MURARRIE 275KV & 110KV SUBSTATION SECONDARY SYSTEMS - EQUIPMENT HEALTH INDICES AND RECOMMENDED REPLACEMENT TIMEFRAME

Notes:
(a): Subject to Powerlink's O&M Safety Requirements, Current Standard Solutions and Implementation Methodologies, it may be more beneficial to align with the recommended replacement timeframe of sedondary systems equipment
(b): Recommended Timeframe is based on majority of Equipment Health Indices
(c): Based on Visual Inspection and Subject to the decision of the Control Building and Secondary Systems Panels. A number of New Cables may be requried if location of control building or secondary systems panels is changed.
(d): As a minimum requirement, Rubber Seals, Air filter and Terminals and Links are required to be repalced by the recommended timeframe. New Marshalling Kiosks should be considered if Exsiting Cables are to be reaplaced.

BAY	C&P PANEL				SECONDARY SYSTEMS EQUIPMENT					X-PROT		Y-PROT		AUX & CTRL		REVENUE METERING		OPSWAN		CABLES (HI)	YARD MARSHALLING KIOSKS (HI)	RECOMMENDED REPLACEMENT TIMMING (Based on Trigger Conditions only, Exclude considerations for Solutions, implementation methodologies)			
																						C&P PANELS (Chassis)	Sec Sys Equipment	CABLES	YARD MARSHALLING KIOSKS
Function	Panel Decripion	Panel No.	Year	HI	Functional Loc.	Description	Manufacturer	Model number	Obsolescence (Yes / No)	Eff. Age	HI	Eff. Age	HI	Eff. Age	HI	Eff. Age	HI	Eff. Age	HI	C&P Panels to HV Yard Marshalling Kiosks (CB, MK, CT, VT, AC, DC, COOLING)	Yard Marshalling Kiosks (CB, MK, CT, VT, AC, DC, COOLING)	C&P Panels	Sec Sys Equipment & Auxiliary Components	C&P Panels to HV Yard Marshalling Kiosks (CB, MK, CT, VT, AC, DC, COOLING)	Yard Marshalling Kiosks (CB, MK, CT, VT, AC, DC, COOLING)
1 BUS	110kV 1 Buszone CBF Bus Trip Buszone 1 RTU	+A1	2003	4.57	H021-SSS-1BU4-BAYCONT	1 BUS ZONE BAY CONTROL UNIT	FOXBORO	C50	Y					14.54	7.27					4.57	4.57	> 2038	2023/24 (b)	> 2038 (c)	> 2038 (d)
					H021-SSS-1BU4-XPROT	1 BUS ZONE X PROTECTION	GE	B30	Y	14.54	7.27														
					H021-SSS-1BU4-XPROT	1 BUS ZONE X PROTECTION	RMS	CB FAIL TRIP RACK	Y	14.54	7.27														
					H021-SSS-1BU4-YPROT	1 BUS ZONE Y PROTECTION	GE	B30	Y			14.54	7.27												
					H021-SSS-1BU4-YPROT	1 BUS ZONE Y PROTECTION	RMS	CB FAIL TRIP RACK	Y			14.54	7.27												
2 BUS	110kV 2 Buszone CBF Bus Trip Buszone 2 RTU	+B1	2003	4.57	H021-SSS-2BU4-BAYCONT	2 BUS ZONE BAY CONTROL UNIT	FOXBORO	C50	Y					14.58	7.29					4.57	4.57	> 2038	2023/24 (b)	> 2038 (c)	> 2038 (d)
					H021-SSS-2BU4-XPROT	2 BUS ZONE X PROTECTION	GE	B30	Y	14.58	7.29														
					H021-SSS-2BU4-XPROT	2 BUS ZONE X PROTECTION	RMS	CB FAIL TRIP RACK	Y	14.58	7.29														
					H021-SSS-2BU4-YPROT	2 BUS ZONE Y PROTECTION	GE	B30	Y			14.58	7.29												
					H021-SSS-2BU4-YPROT	2 BUS ZONE Y PROTECTION	RMS	CB FAIL TRIP RACK	Y			14.58	7.29												
3 BUS	110kV 3 Buszone CBF Bus Trip Buszone 3 RTU	+C1	2003	4.57	H021-SSS-3BU4-BAYCONT	3 BUS ZONE BAY CONTROL UNIT	FOXBORO	C50	Y					14.58	7.29					4.57	4.57	> 2038	2023/24 (b)	> 2038 (c)	> 2038 (d)
					H021-SSS-3BU4-XPROT	3 BUS ZONE X PROTECTION	GE	B30	Y	14.58	7.29														
					H021-SSS-3BU4-XPROT	3 BUS ZONE X PROTECTION	RMS	CB FAIL TRIP RACK	Y	14.58	7.29														
					H021-SSS-3BU4-YPROT	3 BUS ZONE Y PROTECTION	GE	B30	Y			14.58	7.29												
					H021-SSS-3BU4-YPROT	3 BUS ZONE Y PROTECTION	RMS	CB FAIL TRIP RACK	Y			14.58	7.29												
1-2 Bus Section CB 4112 (=D01)	110kV Bus Section 1 Bus -2 Bus (Bay = D01)	+A3	2003	4.57	H021-SSS-411--BAYCONT	1 BUS SECTION BAY CONTROL UNIT	FOXBORO	C50	Y					14.58	7.29					4.57	4.57	> 2038	2023/24 (b)	> 2038 (c)	> 2038 (d)
					H021-SSS-411--XPROT	1 BUS SECTION X PROTECTION	GE	C60 (2.82)	Y	14.58	7.29														
					H021-SSS-411--YPROT	1 BUS SECTION Y PROTECTION	SCHWEITZER	SEL-351-1 (1A)	Y			14.58	7.29												
2-3 Bus Section CB 4122 (=D21)	110kV Bus Section 2 Bus -3 Bus (Bay =D21)	+B5	2003	4.57	H021-SSS-412--BAYCONT	2 BUS SECTION BAY CONTROL UNIT	FOXBORO	C50	Y					14.58	7.29					4.57	4.57	> 2038	2023/24 (b)	> 2038 (c)	> 2038 (d)
					H021-SSS-412--XPROT	2 BUS SECTION X PROTECTION	GE	C60 (2.82)	Y	14.58	7.29														
					H021-SSS-412--YPROT	2 BUS SECTION Y PROTECTION	SCHWEITZER	SEL-351-1 (1A)	Y			14.58	7.29												
T2 TFMR LV CB 4122 (=D19)	110kV T2 TFMR LV CB4422 (Bay =D19)	+B12	2008	3.14	H021-SSS-442--BAYCONT	2 TRANSFORMER CONTROL UNIT	FOXBORO	C50	Y					10.50	5.25					3.14	3.14	> 2043	2028/29 (b)	> 2043 (c)	> 2043 (d)
					H021-SSS-442--XPROT	2 TRANSFORMER X PROTECTION	GE	C60 (VER 2.93)	Y	9.98	4.99														
					H021-SSS-442--YPROT	2 TRANSFORMER Y PROTECTION	SCHWEITZER	SEL-351-1 (1A)	Y			8.83	4.42												
T3 TFMR LV CB 4122 (=D25)	110kV T3 TFMR LV CB4422 (Bay =D25)	+C12	2006	3.71	H021-SSS-443--BAYCONT	3 TRANSFORMER CONTROL UNIT	FOXBORO	C50	Y					11.30	5.65					3.71	3.71	> 2041	2026/27 (b)	> 2041 (c)	> 2041 (d)
					H021-SSS-443--XPROT	3 TRANSFORMER X PROTECTION	GE	C60 (VER 2.93)	Y	11.30	5.65														
					H021-SSS-443--YPROT	3 TRANSFORMER Y PROTECTION	SCHWEITZER	SEL-351-1 (1A)	Y			11.30	5.65												
CAP 2 CB 4822 (=D16)	110kV CAP 2 CB 4822 (=D16)	+A9	2005	4.00	H021-SSS-482--BAYCONT	2 CAPACITOR BAY CONTROL UNIT	FOXBORO	C50	Y					12.13	6.06					4.00	4.00	> 2040	2025/26 (b)	> 2040 (c)	> 2040 (d)
					H021-SSS-482--POWAVE	2 CAPACITOR POINT ON WAVE	ABB	SWITCHSYNC E213	Y					12.13	6.06										
					H021-SSS-482--XPROT	2 CAPACITOR X PROTECTION	ABB	SPAJ160C	N	12.13	6.06														
					H021-SSS-482--XPROT	2 CAPACITOR X PROTECTION	GE	C60 (VER 2.93)	Y	12.13	6.06														
					H021-SSS-482--XPROT	2 CAPACITOR X PROTECTION	ABB	SPAJ140C	N	11.68	5.84														
					H021-SSS-482--YPROT	2 CAPACITOR Y PROTECTION	SCHWEITZER	SEL-351-1 (1A)	Y			12.13	6.06												
CAP 3 CB 4832 (=D23)	110kV CAP 3 - CB 4832 (=D23)	+C7	2005	4.00	H021-SSS-483--BAYCONT	3 CAPACITOR BAY CONTROL UNIT	FOXBORO	C50	Y					12.28	6.14					4.00	4.00	> 2040	2025/26 (b)	> 2040 (c)	> 2040 (d)
					H021-SSS-483--POWAVE	3 CAPACITOR POINT ON WAVE	ABB	SWITCHSYNC E213	Y					12.28	6.14										
					H021-SSS-483--XPROT	3 CAPACITOR X PROTECTION	ABB	SPAJ140C	N	18.31	9.16														
					H021-SSS-483--XPROT	3 CAPACITOR X PROTECTION	ABB	SPAJ160C	N	12.28	6.14														
					H021-SSS-483--XPROT	3 CAPACITOR X PROTECTION	GE	C60 (VER 2.93)	Y	12.28	6.14														
					H021-SSS-483--YPROT	3 CAPACITOR Y PROTECTION	SCHWEITZER	SEL-351-1 (1A)	Y			12.28	6.14												
T2 TFMR HV	275kV T2 TFMR HV	+5A3	2008	3.14	H021-SSS-542--BAYCONT	2 TRANSFORMER BAY CONTROL UNIT	FOXBORO	C50	Y					10.50	5.25					3.14	3.14	> 2043	2028/29 (b)	> 2043 (c)	> 2043 (d)
					H021-SSS-542--XPROT	2 TRANSFORMER X PROTECTION	GE	T60 (3.48)	Y	9.78	4.89														
					H021-SSS-542--XPROT	2 TRANSFORMER X PROTECTION	GE	F35 (2.93)	Y	9.66	4.83														
					H021-SSS-542--XPROT	2 TRANSFORMER X PROTECTION	AREVA	MFAC14	N	8.83	4.42														
					H021-SSS-8837-PSSITA1	8837 SITA1 H021 TO H003 DIG PROT SIG	DEWAR	DM1200 DIGITAL	Y	9.23	4.62														
					H021-SSS-8837-PSSITA2	8837 SITA2 H021 TO H003 DIG PROT SIG	RFL ELECTRONICS	9745 DIGITAL	Y	11.33	5.66														
					H021-SSS-542--YPROT	2 TRANSFORMER Y PROTECTION	SCHWEITZER	SEL-387-5 (1A) (3U)	Y			8.83	4.42												
					H021-SSS-8837-PSSITB1	8837 SITB1 H021 TO H003 DIG PROT SIG	DEWAR	DM1200 DIGITAL	Y			9.23	4.62												
					H021-SSS-8837-PSSITB2	8837 SITB2 H021 TO H003 DIG PROT SIG	RFL ELECTRONICS	9745 DIGITAL	Y			11.33	5.66												
T3 TFMR HV	275kV T3 TFMR HV	+5A1	2006	3.71	H021-SSS-543--BAYCONT	3 TRANSFORMER BAY CONTROL UNIT	FOXBORO	C50	Y					11.30	5.65					3.71	3.71	> 2041	2026/27 (b)	> 2041 (c)	> 2041 (d)
					H021-SSS-543--XPROT	3 TRANSFORMER X PROTECTION	GE	T60 (3.48)	Y	11.30	5.65														
					H021-SSS-543--XPROT	3 TRANSFORMER X PROTECTION	GE	F35 (2.93)	Y	11.30	5.65														
					H021-SSS-543--XPROT	3 TRANSFORMER X PROTECTION	AREVA	MFAC14	N	11.30	5.65														
					H021-SSS-830--PSSITA1	F830 SIT A1 H021 TO H003 DIG PROT SIG	DEWAR	DM1200 DIGITAL	Y	11.31	5.65														
					H021-SSS-830--PSSITA2	F830 SIT A2 H021 TO H003 DIG PROT SIG	RFL ELECTRONICS	9745 DIGITAL	Y	11.33	5.66														
					H021-SSS-543--YPROT	3 TRANSFORMER Y PROTECTION	SCHWEITZER	SEL-387-5 (1A) (3U)	Y			11.30	5.65												
					H021-SSS-830--PSSITB1	F830 SIT B1 H021 TO H003 DIG PROT SIG	RFL ELECTRONICS	9745 DIGITAL	Y			11.33	5.66												
					H021-SSS-830--PSSITB2	F830 SIT B2 H021 TO H003 DIG PROT SIG	DEWAR	DM1200 DIGITAL	Y			11.31	5.65												
FDR 7270 (=D30)	110kV FDR 7270 (LYTTON) - CB 72702	+A6	2003	4.57	H021-SSS-7270-BAYCONT	FEEDER 7270 BAY CONTROL UNIT	FOXBORO	C50	Y					14.54	7.27					4.57	4.57	> 2038	2023/24 (b)	> 2038 (c)	> 2038 (d)
					H021-SSS-7270-XPROT	FEEDER 7270 X PROTECTION	GE	L90 2T : D00 NXX UXX	Y	14.54	7.27														
					H021-SSS-7270-YPROT	FEEDER 7270 Y PROTECTION	SCHWEITZER	SEL-311C (1A)	Y			14.54	7.27												

APPENDIX A - H021 MURARRIE 275KV & 110KV SUBSTATION SECONDARY SYSTEMS - EQUIPMENT HEALTH INDICES AND RECOMMENDED REPLACEMENT TIMEFRAME

Notes:
(a): Subject to Powerlink's O&M Safety Requirements, Current Standard Solutions and Implementation Methodologies, it may be more beneficial to align with the recommended replacement timeframe of secondary systems equipment
(b): Recommended Timeframe is based on majority of Equipment Health Indices
(c): Based on Visual Inspection and Subject to the decision of the Control Building and Secondary Systems Panels. A number of New Cables may be required if location of control building or secondary systems panels is changed.
(d): As a minimum requirement, Rubber Seals, Air filter and Terminals and Links are required to be replaced by the recommended timeframe. New Marshalling Kiosks should be considered if Exsiting Cables are to be replaced.

RECOMMENDED REPLACEMENT TIMMING (Based on Trigger Conditions only, Exclude considerations for Solutions, implementation methodologies)

BAY	C&P PANEL				SECONDARY SYSTEMS EQUIPMENT					X-PROT		Y-PROT		AUX & CTRL		REVENUE METERING		OPSWAN		CABLES (HI)	YARD MARSHALLING KIOSKS (HI)	C&P PANELS (Chassis)	Sec Sys Equipment	CABLES	YARD MARSHALLING KIOSKS
Function	Panel Decripion	Panel No.	Year	HI	Functional Loc.	Description	Manufacturer	Model number	Obsolescence (Yes / No)	Eff. Age	HI	Eff. Age	HI	Eff. Age	HI	Eff. Age	HI	Eff. Age	HI	C&P Panels to HV Yard Marshalling Kiosks (CB, MK, CT, VT, AC, DC, COOLING)	Yard Marshalling Kiosks (CB, MK, CT, VT, AC, DC, COOLING)	C&P Panels	Sec Sys Equipment & Auxiliary Components	C&P Panels to HV Yard Marshalling Kiosks (CB, MK, CT, VT, AC, DC, COOLING)	Yard Marshalling Kiosks (CB, MK, CT, VT, AC, DC, COOLING)
FDR 7271 (=D33)	110kV FDR 7271 (LYTTON) - CB 72712	+C5	2003	4.57	H021-SSS-7271-BAYCONT	FEEDER 7271 BAY CONTROL UNIT	FOXBORO	C50	Y					14.58	7.29					4.57	4.57	> 2038	2023/24 (b)	> 2038 (c)	> 2038 (d)
					H021-SSS-7271-XPROT	FEEDER 7271 X PROTECTION	GE	L90 2T : D00 NXX UXX	Y	14.58	7.29														
					H021-SSS-7271-YPROT	FEEDER 7271 Y PROTECTION	SCHWEITZER	SEL-311C (1A)	Y			14.58	7.29												
FDR 7272 (=D27)	110kV FDR 7272 (DOBOY) - CB 72722	+C3	2003	4.57	H021-SSS-7272-BAYCONT	FEEDER 7272 BAY CONTROL UNIT	FOXBORO	C50	Y					14.57	7.28					4.57	4.57	> 2038	2023/24 (b)	> 2038 (c)	> 2038 (d)
					H021-SSS-7272-XPROT	FEEDER 7272 X PROTECTION	GE	L90 2T : D00 NXX UXX	Y	14.57	7.28														
					H021-SSS-7272-YPROT	FEEDER 7272 Y PROTECTION	SCHWEITZER	SEL-311C (1A)	Y			14.57	7.28												
FDR 7273 (=D13)	110kV FDR 7273 (DOBOY) - CB 72732	+B4	2003	4.57	H021-SSS-7273-BAYCONT	FEEDER 7273 BAY CONTROL UNIT	FOXBORO	C50	Y					14.58	7.29					4.57	4.57	> 2038	2023/24 (b)	> 2038 (c)	> 2038 (d)
					H021-SSS-7273-XPROT	FEEDER 7273 X PROTECTION	GE	L90 2T : D00 NXX UXX	Y	14.58	7.29														
					H021-SSS-7273-YPROT	FEEDER 7273 Y PROTECTION	SCHWEITZER	SEL-311C (1A)	Y			14.58	7.29												
FDR 7274 (=D10)	110kV FDR 7274 (DOBOY) - CB 72742	+A5	2003	4.57	H021-SSS-7274-BAYCONT	FEEDER 7274 BAY CONTROL UNIT	FOXBORO	C50	Y					14.53	7.26					4.57	4.57	> 2038	2023/24 (b)	> 2038 (c)	> 2038 (d)
					H021-SSS-7274-XPROT	FEEDER 7274 X PROTECTION	GE	L90 2T : D00 NXX UXX	Y	14.53	7.26														
					H021-SSS-7274-YPROT	FEEDER 7274 Y PROTECTION	SCHWEITZER	SEL-311C (1A)	Y			14.53	7.26												
FDR 7287 (=D09)	110kV FDR 7287 (BELMONT - TEE WELLINGTON ROAD) - CB 72872	+B11	2005	4.00	H021-SSS-7287-BAYCONT	FEEDER 7287 BAY CONTROL UNIT	FOXBORO	C50	Y					12.21	6.10					4.00	4.00	> 2040	2025/26 (b)	> 2040 (c)	> 2040 (d)
					H021-SSS-7287-XPROT	FEEDER 7287 X PROTECTION	GE	L90 3T : D00 N6U U6T	Y	12.21	6.10														
					H021-SSS-7287-YPROT	FEEDER 7287 Y PROTECTION	SCHWEITZER	SEL-311C (1A)	Y			12.21	6.10												
FDR 7288 (=D06)	110kV FDR 7288 (BELMONT - TEE WELLINGTON ROAD) - CB 72882	+A8	2005	4.00	H021-SSS-7288-BAYCONT	FEEDER 7288 BAY CONTROL UNIT	FOXBORO	C50	Y					12.01	6.01					4.00	4.00	> 2040	2025/26 (b)	> 2040 (c)	> 2040 (d)
					H021-SSS-7288-XPROT	FEEDER 7288 X PROTECTION	GE	L90 3T : D00 N6U U6T	Y	12.01	6.01														
					H021-SSS-7288-YPROT	FEEDER 7288 Y PROTECTION	SCHWEITZER	SEL-311C (1A)	Y			12.01	6.01												
FDR 752 (=D05)	110kV FDR 752 (NEWSTEAD) - CB 7522	+B3	2003	4.57	H021-SSS-752--BAYCONT	FEEDER 752 BAY CONTROL UNIT	FOXBORO	C50	Y					14.58	7.29					4.57	4.57	> 2038	2023/24 (b)	> 2038 (c)	> 2038 (d)
					H021-SSS-752--XPROT	FEEDER 752 X PROTECTION	GE	L90 2T : D00 NXX UXX	Y	14.58	7.29														
					H021-SSS-752--YPROT	FEEDER 752 Y PROTECTION	SCHWEITZER	SEL-311C (1A)	Y			14.58	7.29												
FDR 753 (=D02)	110kV FDR 752 (NEWSTEAD) - CB 7532	+A4	2003	4.57	H021-SSS-753--BAYCONT	FEEDER 753 BAY CONTROL UNIT	FOXBORO	C50	Y					14.53	7.26					4.57	4.57	> 2038	2023/24 (b)	> 2038 (c)	> 2038 (d)
					H021-SSS-753--XPROT	FEEDER 753 X PROTECTION	GE	L90 2T : D00 NXX UXX	Y	14.53	7.26														
					H021-SSS-753--YPROT	FEEDER 753 Y PROTECTION	SCHWEITZER	SEL-311C (1A)	Y			14.53	7.26												
FDR 830 (=C01)	275kV Feeder 830 (BELMONT) - CB 8302	+5A2	2006	3.71	H021-SSS-830--BAYCONT	FEEDER 830 BAY CONTROL UNIT	FOXBORO	C50	Y					11.30	5.65					3.71	3.71	> 2041	2026/27 (b)	> 2041 (c)	> 2041 (d)
					H021-SSS-830--XPROT	FEEDER 830 X PROTECTION	MICOM	P544 (+ 2nd Port)	Y	11.30	5.65														
					H021-SSS-830--YPROT	FEEDER 830 Y PROTECTION	SCHWEITZER	SEL-421 (1A) (5U)	Y			11.30	5.65												
					H021-SSS-830--PSPITY	F830 PIT Y +IAR H021-H003 DIG PROT SIG	DEWAR	DM1200 DIGITAL	Y			11.31	5.65												
	+5B2 - 275kV Comms and MUX	+5B2			H021-SSS-830--XPROT	FEEDER 830 X PROTECTION	ALSTOM	MIT201	Y	11.30	5.65														
FDR 8837 (=C02)	275kV Feeder 8837 (BELMONT) - CB 88372	+5A4	2008	3.14	H021-SSS-8837-BAYCONT	FEEDER 8837 BAY CONTROL UNIT	FOXBORO	C50	Y					10.50	3.25					3.14	3.14	> 2043	2028/29 (b)	> 2043 (c)	> 2043 (d)
					H021-SSS-8837-XPROT	FEEDER 8837 X PROTECTION	MICOM	P544 (+ 2nd Port)	Y	8.83	4.42														
					H021-SSS-8837-YPROT	FEEDER 8837 Y PROTECTION	SCHWEITZER	SEL-421 (1A) (5U)	Y			9.47	4.74												
					H021-SSS-8837-PSPITY	8837 PIT Y H021 TO H003 DIG PROT SIG	DEWAR	DM1200 DIGITAL	Y			9.23	4.62												
	+5B2 - 275kV Comms and MUX	+5B2			H021-SSS-8837--XPROT	FEEDER 8837 X PROTECTION	ALSTOM	P391	Y	8.83	4.42														
REVMET 4, 6 8 (FDRs 7273, 752, 7287)	110kV REVENUE METERING PANEL - FDRs 7273, 752 and 7287	+B6	2005	4.00	H021-SSS-METR-REVMET6	FDR 752 ENERGY METERING (REVENUE)	EDMI	2000-0400-211-0-1-Q	Y							12.81	6.40			4.00	4.00	> 2040	2025/26 (b)	> 2040 (c)	> 2040 (d)
					H021-SSS-METR-REVMET6	FDR 752 ENERGY METERING (REVENUE)	EDMI	2000-0400 1A Cl 0.5	Y							9.57	4.79								
					H021-SSS-METR-REVMET4	FDR 7273 ENERGY METERING (REVENUE)	EDMI	2000-0400 1A Cl 0.5	Y							13.97	6.98								
					H021-SSS-METR-REVMET4	FDR 7273 ENERGY METERING (REVENUE)	EDMI	2000-0400 1A Cl 0.5	Y							13.97	6.98								
					H021-SSS-METR-REVMET8	FDR 7287 ENERGY METERING (REVENUE)	EDMI	2000-0400 1A Cl 0.5	Y							10.82	5.41								
					H021-SSS-METR-REVMET8	FDR 7287 ENERGY METERING (REVENUE)	EDMI	2000-0400 1A Cl 0.5	Y							10.82	5.41								
REVMET 2, 3 (FDRs 7271, 7272)	110kV REVENUE METERING PANEL - FDRs 7271 and 7272	+C6	2003	4.57	H021-SSS-METR-REVMET2	FDR 7271 ENERGY METERING (REVENUE)	EDMI	2000-0400 1A Cl 0.5	Y							14.58	7.29			4.57	4.57	> 2038	2023/24 (b)	> 2038 (c)	> 2038 (d)
					H021-SSS-METR-REVMET2	FDR 7271 ENERGY METERING (REVENUE)	EDMI	2000-0400 1A Cl 0.5	Y							8.46	4.23								
					H021-SSS-METR-REVMET3	FDR 7272 ENERGY METERING (REVENUE)	EDMI	2000-0400 1A Cl 0.5	Y							13.97	6.98								
					H021-SSS-METR-REVMET3	FDR 7272 ENERGY METERING (REVENUE)	EDMI	2000-0400 1A Cl 0.5	Y							13.97	6.98								
REVMET 4, 6 8 (FDRs 7270, 7274, 753 and 7288)	110kV REVENUE METERING PANEL - FDRs 7270, 7274, 753 and 7288	+A7	2004	4.29	H021-SSS-METR-REVMET1	FDR 7270 ENERGY METERING (REVENUE)	EDMI	2000-0400 1A Cl 0.5	Y							18.35	9.18			4.29	4.29	> 2039	2024/25 (b)	> 2039 (c)	> 2039 (d)
					H021-SSS-METR-REVMET1	FDR 7270 ENERGY METERING (REVENUE)	EDMI	2000-0400 1A Cl 0.5	Y							14.54	7.27								
					H021-SSS-METR-REVMET5	FDR 7274 ENERGY METERING (REVENUE)	EDMI	2000-0400 1A Cl 0.5	Y							13.97	6.98								
					H021-SSS-METR-REVMET5	FDR 7274 ENERGY METERING (REVENUE)	EDMI	2000-0400 1A Cl 0.5	Y							13.97	6.98								
					H021-SSS-METR-REVMET7	FDR 753 ENERGY METERING (REVENUE)	EDMI	2000-0400-211-0-1-Q	Y							12.81	6.40								
					H021-SSS-METR-REVMET7	FDR 753 ENERGY METERING (REVENUE)	EDMI	2000-0400-211-0-1-Q	Y							12.73	6.36								
					H021-SSS-METR-REVMET9	FDR 7288 ENERGY METERING (REVENUE)	EDMI	2000-0400 1A Cl 0.5	Y							10.91	5.45								
					H021-SSS-METR-REVMET9	FDR 7288 ENERGY METERING (REVENUE)	EDMI	2000-0400 1A Cl 0.5	Y							10.91	5.45								

APPENDIX A - H021 MURARRIE 275KV & 110KV SUBSTATION SECONDARY SYSTEMS - EQUIPMENT HEALTH INDICES AND RECOMMENDED REPLACEMENT TIMEFRAME

Notes:
(a): Subject to Powerlink's O&M Safety Requirements, Current Standard Solutions and Implementation Methodologies, it may be more beneficial to align with the recommended replacement timeframe of sedondary systems equipment
(b): Recommended Timeframe is based on majority of Equipment Health Indices
(c): Based on Visual Inspection and Subject to the decision of the Control Building and Secondary Systems Panels. A number of New Cables may be required if location of control building or secondary systems panels is changed.
(d): As a minimum requirement, Rubber Seals, Air filter and Terminals and Links are required to be replaced by the recommended timeframe. New Marshalling Kiosks should be considered if Existing Cables are to be reaplaced.

																				RECOMMENDED REPLACEMENT TIMMING (Based on Trigger Conditions only, Exclude considerations for Solutions, implementation methodologies)				
BAY	C&P PANEL				SECONDARY SYSTEMS EQUIPMENT					X-PROT		Y-PROT		AUX & CTRL		REVENUE METERING		OPSWAN		CABLES (HI)	YARD MARSHALLING KIOSKS (HI)	C&P PANELS (Chassis)	Sec Sys Eqiupment	CABLES	YARD MARSHALLING KIOSKS
Function	Panel Description	Panel No.	Year	HI	Functional Loc.	Description	Manufacturer	Model number	Obsolescence (Yes / No)	Eff. Age	HI	Eff. Age	HI	Eff. Age	HI	Eff. Age	HI	Eff. Age	HI	C&P Panels to HV Yard Marshalling Kiosks (CB, MK, CT, VT, AC, DC, COOLING)	Yard Marshalling Kiosks (CB, MK, CT, VT, AC, DC, COOLING)	C&P Panels	Sec Sys Equipment & Auxiliary Components	C&P Panels to HV Yard Marshalling Kiosks (CB, MK, CT, VT, AC, DC, COOLING)	Yard Marshalling Kiosks (CB, MK, CT, VT, AC, DC, COOLING)
"+4" COMMON & OPSWAN	BUILDING +4 COMMON RTU AND OPSWAN	+T	2010	2.57	H021-SSS-NBAY-INVERTT	DC - AC INVERTER BUILDING "T"	LATRONICS	LITRO 100	N									14.00	10.00	2.57	2.57	> 2045	2030/31 (b)	> 2045 (c)	> 2045 (d)
					H021-SSS-NBAY-LCFT	LOCAL CONTROL FACILITY BUILDING "T"	WYSE	Z90D7	Y					0.42	0.42										
					H021-SSS-NBAY-OWHUBT	OPSWAN HUB BUILDING "T"	[redacted]		Y									7.63	7.63						
					H021-SSS-NBAY-OWHUBT	OPSWAN HUB BUILDING "T"			N									4.09	4.09						
					H021-SSS-NBAY-OWPRINTT	OPSWAN PRINTER BUILDING "T"	HEWLETT PACKARD	HP5200TN	Y									8.00	8.00						
"+A" MASTER LCF NSC & OPSWAN	BUILDING +A SUBSTATION MASTER LCF NSCs and OPSWAN CUBICLE	+A24	1999	5.71	H021-SSS-NBAY-INTSWITA	SUB INTERROGATION SWITCH BUILDING "A"	COMMUNITRON	DATAGATE	Y									18.00	9.00	5.71	5.71	> 2034	2019/20 (b)	> 2034 (c)	> 2034 (d)
					H021-SSS-NBAY-INVERTA	DC - AC INVERTER BUILDING "A"	LATRONICS	IRM18120	N					7.00	3.50										
					H021-SSS-NBAY-LCFA	LOCAL CONTROL FACILITY BUILDING "A"	SUN	21"	Y					14.00	10.00										
					H021-SSS-NBAY-LCFA	LOCAL CONTROL FACILITY BUILDING "A"	WYSE	Z90D7	Y					0.42	0.42										
					H021-SSS-NBAY-LCFINT	LOCAL CONTROL FACILITY INTERFACE	FOXBORO	C50	Y					14.58	7.29										
					H021-SSS-NBAY-NSCLINK1	NSC LINK 1	FOXBORO	C50	Y					14.58	7.29										
					H021-SSS-NBAY-NSCLINK2	NSC LINK 2	FOXBORO	C50	Y					14.58	7.29										
					H021-SSS-NBAY-OWCOVRTA	OPSWAN CONVERTER BUILDING A	PHOENIX	QUINT-PS-100	N									7.00	3.50						
					H021-SSS-NBAY-OWHUBA	OPSWAN HUB BUILDING "A"	[redacted]		N									7.63	7.63						
					H021-SSS-NBAY-OWHUBA	OPSWAN HUB BUILDING "A"			N									7.63	7.63						
					H021-SSS-NBAY-OWNTWKA	OPSWAN NETWORK BUILDING "A"			N									0.00	0.00						
					H021-SSS-NBAY-TIMINGA	TIMING SYSTEM BUILDING "A"	TEKRON	TCG01	Y					14.58	7.29										
"+B" OPSWAN	BUILDING +B OPSWAN CUBICLE	+B14	2003	4.57	H021-SSS-NBAY-LCFB	LOCAL CONTROL FACILITY BUILDING "B"	COMPAQ	HP1825	Y					14.00	10.00					4.57	4.57	> 2038	2023/24 (b)	> 2038 (c)	> 2038 (d)
					H021-SSS-NBAY-LCFB	LOCAL CONTROL FACILITY BUILDING "B"	COMPAQ	PROLIANT ML350	Y					13.66	10.00										
					H021-SSS-NBAY-LCFB	LOCAL CONTROL FACILITY BUILDING "B"	WYSE	Z90D7	Y					0.42	0.42										
					H021-SSS-NBAY-INTSWITB	SUB INTERROGATION SWITCH BUILDING "B"	COMMUNITRON	DATAGATE	Y							14.58	7.29								
					H021-SSS-NBAY-INVERTB	DC - AC INVERTER BUILDING "B"	LATRONICS	IRM18120	N									7.00	3.50						
					H021-SSS-NBAY-OWCOVRTB	OPSWAN CONVERTER BUILDING B	PHOENIX	QUINT-PS-100	N									7.00	3.50						
					H021-SSS-NBAY-OWHUBB	OPSWAN HUB BUILDING "B"	[redacted]		N									7.63	7.63						
					H021-SSS-NBAY-OWHUBB	OPSWAN HUB BUILDING "B"			N									7.63	7.63						
"+C" OPSWAN	BUILDING +C OPSWAN CUBICLE	+C14	2003	4.57	H021-SSS-NBAY-INVERTC	DC - AC INVERTER BUILDING "C"	LATRONICS	IRM18120	N					7.00	3.50					4.57	4.57	> 2038	2023/24 (b)	> 2038 (c)	> 2038 (d)
					H021-SSS-NBAY-LCFC	LOCAL CONTROL FACILITY BUILDING "C"	COMPAQ	HP1825	Y					14.00	10.00										
					H021-SSS-NBAY-LCFC	LOCAL CONTROL FACILITY BUILDING "C"	COMPAQ	PROLIANT ML350	Y					13.66	10.00										
					H021-SSS-NBAY-LCFC	LOCAL CONTROL FACILITY BUILDING "C"	WYSE	Z90D7	Y					0.42	0.42										
					H021-SSS-NBAY-OWHUBC	OPSWAN HUB BUILDING "C"	[redacted]		N									7.63	7.63						
					H021-SSS-NBAY-OWHUBC	OPSWAN HUB BUILDING "C"			N									7.63	7.63						
					H021-SSS-NBAY-TIMINGC	TIMING SYSTEM BUILDING "C"	TEKRON	TCG01	Y					12.10	6.05										
					H021-SSS-NBAY-OWCOVRTC	OPSWAN CONVERTER BUILDING C	PHOENIX	QUINT-PS-100	N									7.00	3.50						

APPENDIX A - H021 MURARRIE 275KV & 110KV SUBSTATION SECONDARY SYSTEMS - EQUIPMENT HEALTH INDICES AND RECOMMENDED REPLACEMENT TIMEFRAME

Notes:
(a): Subject to Powerlink's O&M Safety Requirements, Current Standard Solutions and Implementation Methodologies, it may be more beneficial to align with the recommended replacement timeframe of sedondary systems equipment
(b): Recommended Timeframe is based on majority of Equipment Health Indices
(c): Based on Visual Inspection and Subject to the decision of the Control Building and Secondary Systems Panels. A number of New Cables may be required if location of control building or secondary systems panels is changed.
(d): As a minimum requirement, Rubber Seals, Air filter and Terminals and Links are required to be replaced by the recommended timeframe. New Marshaling Kiosks should be considered if Existing Cables are to be replaced.

																					RECOMMENDED REPLACEMENT TIMMING (Based on Trigger Conditions only, Exclude considerations for Solutions, implementation methodologies)				
BAY	C&P PANEL				SECONDARY SYSTEMS EQUIPMENT					X-PROT		Y-PROT		AUX & CTRL		REVENUE METERING		OPSWAN		CABLES (HI)	YARD MARSHALLING KIOSKS (HI)	C&P PANELS (Chassis)	Sec Sys Eqiupment	CABLES	YARD MARSHALLING KIOSKS
Function	Panel Description	Panel No.	Year	HI	Functional Loc.	Description	Manufacturer	Model number	Obsolescence (Yes / No)	Eff. Age	HI	Eff. Age	HI	Eff. Age	HI	Eff. Age	HI	Eff. Age	HI	C&P Panels to HV Yard Marshalling Kiosks (CB, MK, CT, VT, AC, DC, COOLING)	Yard Marshalling Kiosks (CB, MK, CT, VT, AC, DC, COOLING)	C&P Panels	Sec Sys Equipment & Auxiliary Components	C&P Panels to HV Yard Marshalling Kiosks (CB, MK, CT, VT, AC, DC, COOLING)	Yard Marshalling Kiosks (CB, MK, CT, VT, AC, DC, COOLING)
"+5" OPSWAN	BUILDING +5 COMMON RTU AND OPSWAN	+581	2006	3.71	H021-SSS-NBAY-LCF5	LOCAL CONTROL FACILITY BUILDING +5	HEWLETT PACKARD	L1740	Y					11.00	10.00					3.71	3.71	> 2041	2026/27 (b)	> 2041 (c)	> 2041 (d)
					H021-SSS-NBAY-LCF5	LOCAL CONTROL FACILITY BUILDING +5	WYSE	Z90D7	Y					0.42	0.42										
					H021-SSS-NBAY-OWCOVRT5	OPSWAN CONVERTER BUILDING 5	PHOENIX	QUINT-PS-100	N									7.00	3.50						
					H021-SSS-NBAY-OWINVRT5	OPSWAN INVERTER BUILDING +5	LATRONICS	LITRO 100	N									11.00	5.50						
					H021-SSS-NBAY-OWNTWK5	OPSWAN NETWORK BUILDING +5	[redacted]		Y									7.63	7.63						
					H021-SSS-NBAY-OWNTWK5	OPSWAN NETWORK BUILDING +5			N									7.63	7.63						
					H021-SSS-NBAY-RTUCOM5	COMMON RTU BUILDING +5	FOXBORO	C50	Y					11.30	5.65										
					H021-SSS-NBAY-TIMING5	TIMING SYSTEM BUILDING +5	TERRON	TCG01	Y					11.30	5.65										
"+T" OPSWAN & COMMS RTU	BUILDING +T OPSWAN CAMERA AND COMMS RTU	+T	2003	4.57	H021-SSS-NBAY-OWCAM1	OPSWAN CAMERA 1	CANON	VC-C4R	Y									14.00	10.00	4.57	4.57	> 2038	2023/24 (b)	> 2038 (c)	> 2038 (d)
					H021-SSS-NBAY-OWCAM2	OPSWAN CAMERA 2	CANON	VC-C4R	Y									14.00	10.00						
					H021-SSS-NBAY-RTUCOM	COMMON RTU	FOXBORO	C50	Y					14.58	7.29										
					H021-SSS-NBAY-OWSERV	OPSWAN SERVER	Esis	E815002	N									0.00	0.00						
110kV PQM	110kV PQM	+C11	2015	0.86	H021-SSS-NBAY-PWRQUAL1	POWER QUALITY MONITOR 1	UNIPOWER	UP-2210	Y					1.12	0.56					0.86	0.86	> 2051	2036/37 (b)	> 2051 (c)	> 2051 (d)
					H021-SSS-NBAY-PWRQUAL2	POWER QUALITY MONITOR 2	UNIPOWER	UP-2210	Y					1.12	0.56										

Planning Statement	17/04/2020
Title	CP.02751– H021 Murarrie Secondary Systems Replacement – Planning Statement[1]
Zone	Moreton
Need Driver	Emerging risks arising from the condition and obsolescence of Murarrie's ageing secondary systems requiring replacement by June 2027.
Network Limitations and statutory requirements	Murarrie Substation is required to meet Powerlink Queensland's N-1-50MW/600MWh reliability obligations to residential, commercial and industrial loads within the Brisbane area, including the CBD, TradeCoast and Port of Brisbane.
Pre-requisites	None

Executive Summary

Ageing and obsolete secondary systems at Murarrie 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's forecasts confirm there is an enduring need to maintain electricity supply to industrial, commercial and residential loads supplied from Murarrie 275/110kV Substation. These loads include the Brisbane eastern suburbs, eastern ring of Brisbane CBD, Port of Brisbane and TradeCoast area.

The removal of functionality currently provided by Murarrie Substation would violate Powerlink's N-1-50MW/600MWh Transmission Authority reliability standard.

[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

Murarrie 275kV Substation (H021) was established in 2003 and together with Belmont 275kV Substation provides injection points to the Powerlink and Energy Queensland (Energex) eastern 110kV sub-transmission ring. This network supplies residential, industrial and commercial loads within the Brisbane area including the eastern Brisbane suburbs, eastern ring of Brisbane CBD, Port of Brisbane and TradeCoast area.

Figure 1 shows the existing Powerlink 275kV and 110kV transmission network supplying the greater Brisbane area. An Energex 110kV sub-transmission system extends from both Belmont and Murarrie Substations to supply bulk supply points and the distribution network within the eastern Brisbane area.

Figure 2 shows the system diagram for the eastern portion of the Powerlink 275kV and 110kV network, and the Energex 110kV sub-transmission system. Murarrie Substation has three key supply injections into the Energex system as follows:

- Energex bulk supply point Doboy Substation (SSDBD) supplying residential, commercial and light industrial loads within the eastern Brisbane area.
- Energex bulk supply points Lytton substations (SSLBS and SST114). The Murarrie to SSLBS system are the 110kV sub-transmission feeds to the Brisbane Port and TradeCoast areas.
- A number of Energex bulk supply points supplying the eastern Brisbane suburbs and Brisbane CBD. This network is also supported by Belmont 275/110kV Substation. The Powerlink and Energex 110kV sub-transmission networks supply key bulk supply points including Newstead (SSNSD), Wellington Road (SSWRD), Charlotte Street (SSCST), Ann Street (SSAST), and Victoria Park (SSVPK).

Figure 1 – Powerlink Transmission Network within the Metropolitan Brisbane Area

A condition assessment of the secondary systems at Murarrie Substation has determined that they are reaching the end of their technical service lives, with many components no longer supported by the manufacturer and limited spares available. Increasing failure rates, along with the increased time to rectify faults due to the obsolescence of the equipment, significantly affects the availability and reliability of these systems and their ability to continue to meet the requirements of the National Electricity Rules (the Rules).

In addition to the site-specific impacts of obsolescence at Murarrie Substation, it is also important to note the compounding impact of equipment obsolescence occurring across the fleet of secondary systems assets installed in the Powerlink network. Running multiple secondary systems to failure across the network increases the likelihood of concurrent systemic faults with significant implications for network reliability and safety.

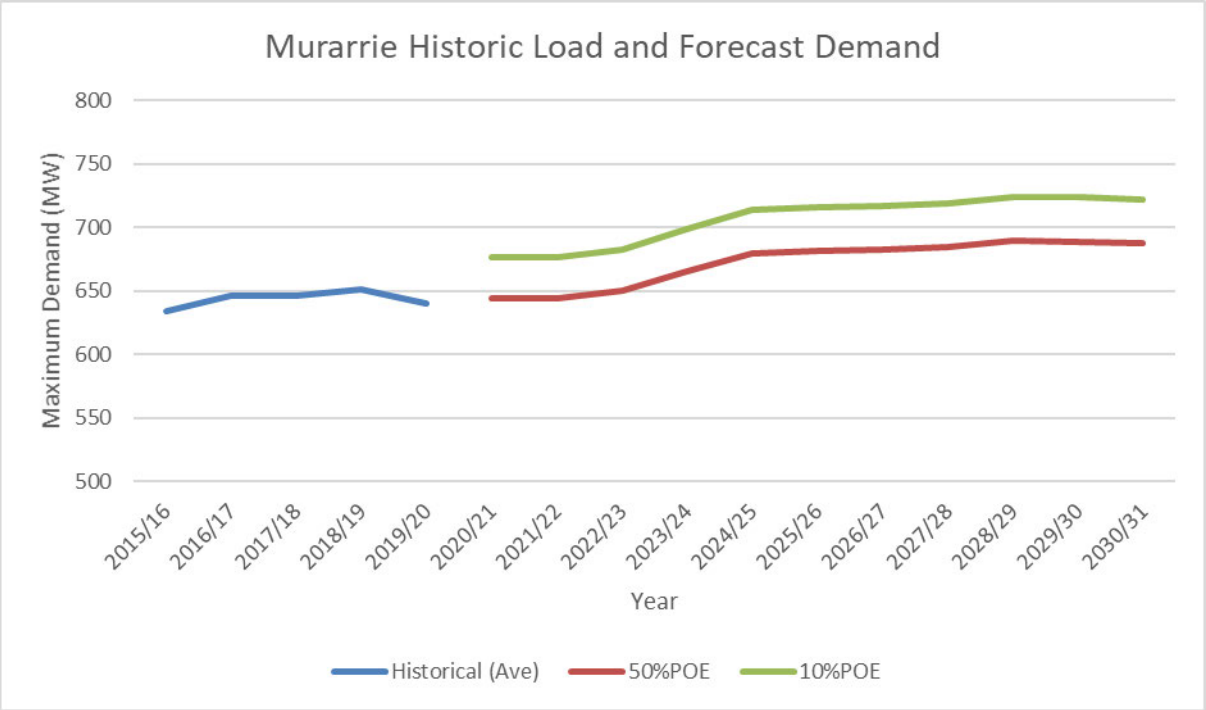
This report assess the impact that removal of end of life secondary systems would have on the performance of the network and Powerlink's statutory obligations. It also establishes the indicative requirements of any potential alternative solutions to the current services provided by Murarrie Substation.

2. Demand Forecasts

Murarrie Substation supplies residential, industrial and commercial loads within the eastern part of the Brisbane metropolitan area. The 10% PoE and 50% PoE maximum demand forecasts for load supplied by Murarrie Substation are shown in Figure 3.

Powerlink is predicting an average of 0.68% per annum increases in Energex loads over the ten year forecasting horizon. The load forecast confirms an enduring need for the existing functionality provided by Murarrie Substation in suppling load within the Brisbane Metropolitan area.

Figure 3 - Murarrie Historic Load and Forecast Demand



3. Statement of Investment Need

Murarrie 275/110kV Substation is a major injection point into the Powerlink and Energex 110kV sub-transmission network supplying residential, commercial and industrial loads within eastern Brisbane. These loads include Brisbane CBD, Brisbane Port and the TradeCoast area.

Removing the functionality provided by Murarrie Substation will mean that the existing network will no longer meet Powerlink's N-1-50MW / 600MWh reliability standard.

As the secondary systems are required to operate Murarrie Substation, it is proposed that they be replaced to ensure ongoing compliance with Powerlink's Rules and Transmission Authority obligations.

4. Network Risk

Table 1 below presents load flow analysis conducted to determine the maximum load and energy at risk associated with Murarrie Substation.

Table 1: Murarrie Load and Energy at Risk

At Risk	Contingency	Metric*	2025
Brisbane CDB East ring, Doboy BS, Lytton BS	Murarrie 275/110kV Transformers (T2 and T3) or 275kV Feeders into Murarrie (830&8837)	Max (MW)	45
		Average (MW)	0.012
		24h Energy Unserved Max (MWh)	41
		24h Energy Unserved Average (MWh)	0.3
Lytton BS (Note. ~63MW load can be transferred to Doboy SS)	Loss of two 110kV feeder into Lytton (7270&7271)	Max (MW)	115
		Average (MW)	12.7
		24h Energy Unserved Max (MWh)	884.4
		24h Energy Unserved Average (MWh)	305.4
Charlotte St SS, Ann St SS (Brisbane CDB East ring), Wellington Rd SS	Loss of one Newstead-Murarrie 110kV feeder and one 110kV Tingalpa Tee point feeder	Max (MW)	67.5
		Average (MW)	1.2
		24h Energy Unserved Max (MWh)	554
		24h Energy Unserved Average (MWh)	29.8
Charlotte St SS, Ann St SS (Brisbane CDB East ring), Wellington Rd SS	Loss of one Murarrie-Tingalpa Tee 110kV feeder and 110kV Tingalpa Tee point feeders	Max (MW)	67.5
		Average (MW)	1.2
		24h Energy Unserved Max (MWh)	554
		24h Energy Unserved Average (MWh)	29.8

* Maximum load at risk assumes intact system conditions which excludes pre-contingent load transfers through the Energex distribution system. However unserved energy assumes that post-contingent switching and transfers are available and have occurred within the EQL distribution network.

5. Non Network Options

The substation hosts two 275/110kV transformers to facilitate supply to the Energy Queensland bulk supply points including Doboy, Lytton and the eastern inner city Brisbane areas.

Non-network solutions must be capable of meeting up to 115 MW of power and 885 MWh of energy each day to replace the current functionality provided by Murarrie 275/110kV Substation. The non-network solution would be required to be capable of operating during a contingency or outage on a continuous basis until normal supply is restored.

Potential non-network solutions may be able to provide supply to individual 110kV injection points, and this may reduce the scope of the secondary systems replacement project. Non-network requirements for individual bays would be as detailed within Table 1 above.

Powerlink is currently not aware of any Demand Side Solutions (DSM) in the area supplied by Murarrie Substation. However, Powerlink will consider any proposed non-network solutions that may be able to contribute to the requirement functionality provided by Murarrie Substation.

6. Network Options

6.1 Proposed Option to address the identified need

It is recommended that the replacement of the secondary systems at Murarrie Substation be completed no later than June 2027. Further details of end of life drivers for the secondary systems at Murarrie Substation can be found in Reference 1.

6.2 Option Considered but Not Proposed

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

6.2.1 Reinforcement of Belmont Substation and associated 110kV system

The reinforcement of the existing Belmont 275/110kV Substation and associated 110kV sub-transmission system to replace the functionality provided by Murarrie Substation was examined, but was not considered commercially feasible due to the significantly higher cost compared to the secondary systems works proposed for Murarrie Substation. In addition some level of partial secondary systems work at Murarrie Substation would need to be performed.

6.2.2 Establishment of Cross River 110kV ring from South Pine Substation

The reinforcement of the existing South Pine to Nudgee 110kV network within Brisbane north and installation of cross river cable to replace the functionality provided by Murarrie Substation was examined, but was not considered commercially feasible due to the significantly higher costs. In addition some level of partial secondary systems work at Murarrie Substation would need to be performed.

6.2.3 Installation of Battery Energy Storage System (BESS) at Murarrie Substation

The installation of a 885MWh battery energy storage system at Murarrie Substation was examined, but was not considered commercially feasible due to the significantly higher cost compared to replacement of the secondary systems at Murarrie Substation.

However any non-network solution involving batteries or other technologies identified through the RIT-T public consultation process at the time of investment will be considered where these are technically and commercially feasible.

7. Recommendations

Powerlink has reviewed the condition of the secondary systems at Murarrie Substation and anticipates they will reach end of technical service life by 2027. It is therefore recommended that the systems be replaced by no later than June 2027.

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

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

8. References

1. H021 Murarrie Secondary Systems Condition Assessment Report 20 March 2020
2. Transmission Annual Planning Report 2020
3. Asset Planning Criteria Framework

Base Case Risk and Maintenance Costs Summary Report

CP.02751 H021 Murarrie Secondary Systems Replacement

Version Number	Objective ID	Date	Description
1.0	A4425094	05/11/2020	Original document.

1 Purpose

The purpose of this model is to quantify the base case risk cost profiles and maintenance costs for the secondary systems at Murarrie substation which are candidates for reinvestment under CP.02751.

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

2 Key Assumptions

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

- spares for secondary system items have been assumed to be available prior to the point of expected spares depletion, as 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 concurrent failure events;
- unserved energy generally accrues under concurrent failure events, and consideration has been given to potential feeder trip events within the wider area;
- Murarrie substation supplies a mixture of residential, commercial and industrial load types. Historical load data has been analysed to approximate the ratio of residential, commercial and industrial loads resulting in a VCR of $44,336/MWh; and
- The most relevant residential, commercial and industrial VCR values published within the AER's 2019 Value of Customer Reliability Review Final Report have been used to determine the VCR.

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 are considered material and are modelled in this analysis.

3.2 Secondary Systems Analysis

This section analyses the risks presented by the relevant secondary systems at Murarrie 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 increases 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.

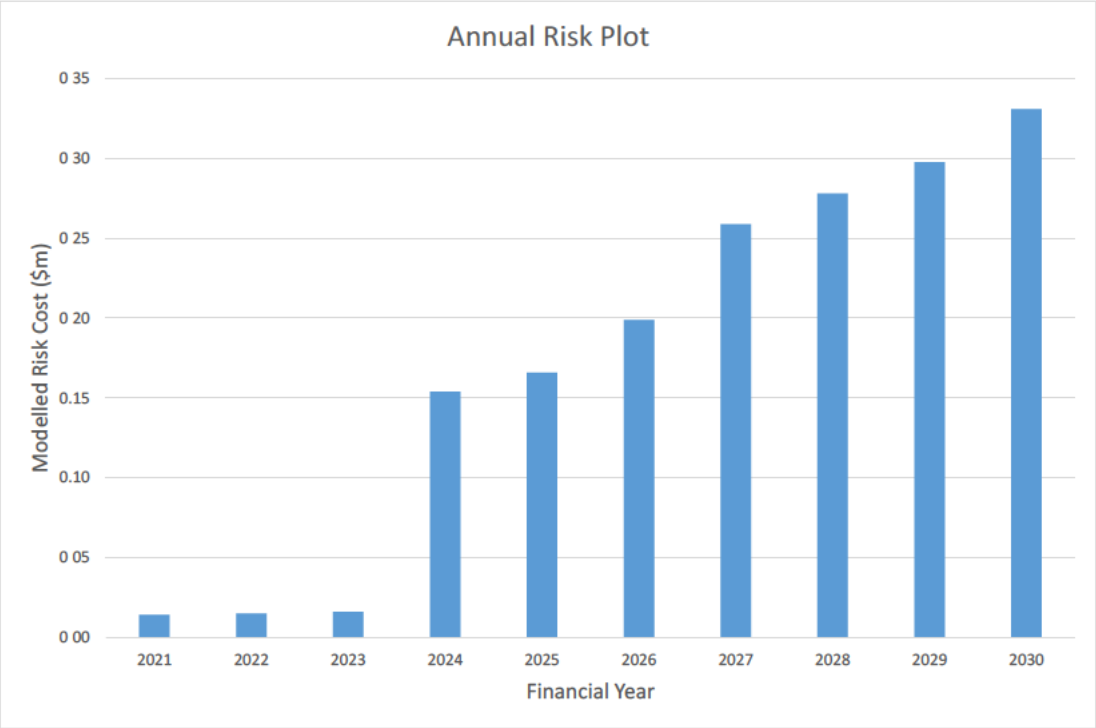


Figure 1 – Murarrie secondary systems total risk

Figure 2 – Murarrie secondary systems risk (10 and 15 years)[2]

[2] The significant increase in modelled risk cost in 2024 coincides with the depletion of available spares for the majority of in-scope secondary systems.

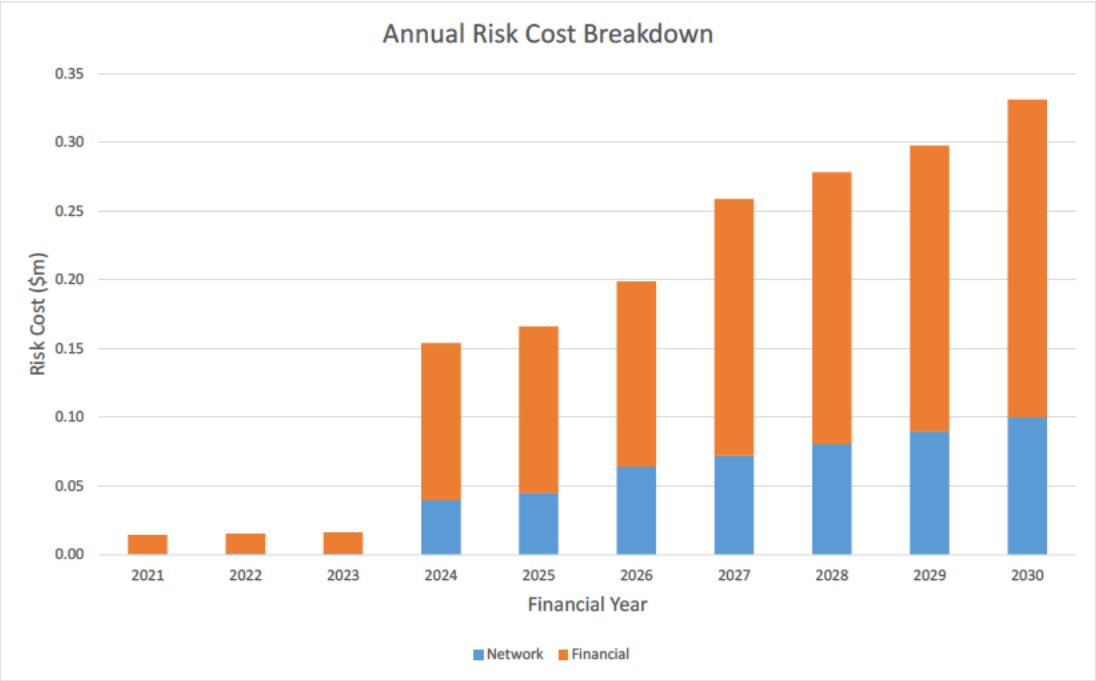


Figure 3 – Murarrie secondary systems risk by risk category

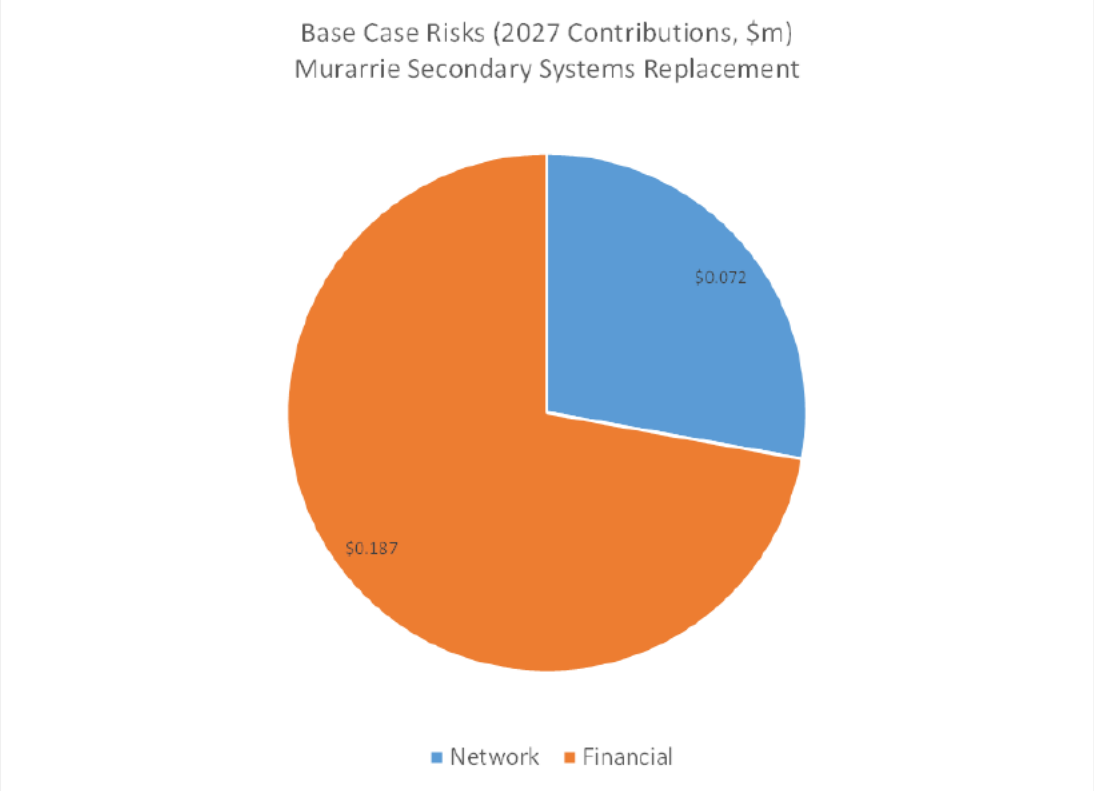


Figure 4 - Murarrie 2024 risk by risk category

3.4 Base Case Risk Statement

The main base case risks for the secondary systems at Murarrie 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 Maintenance Costs

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

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

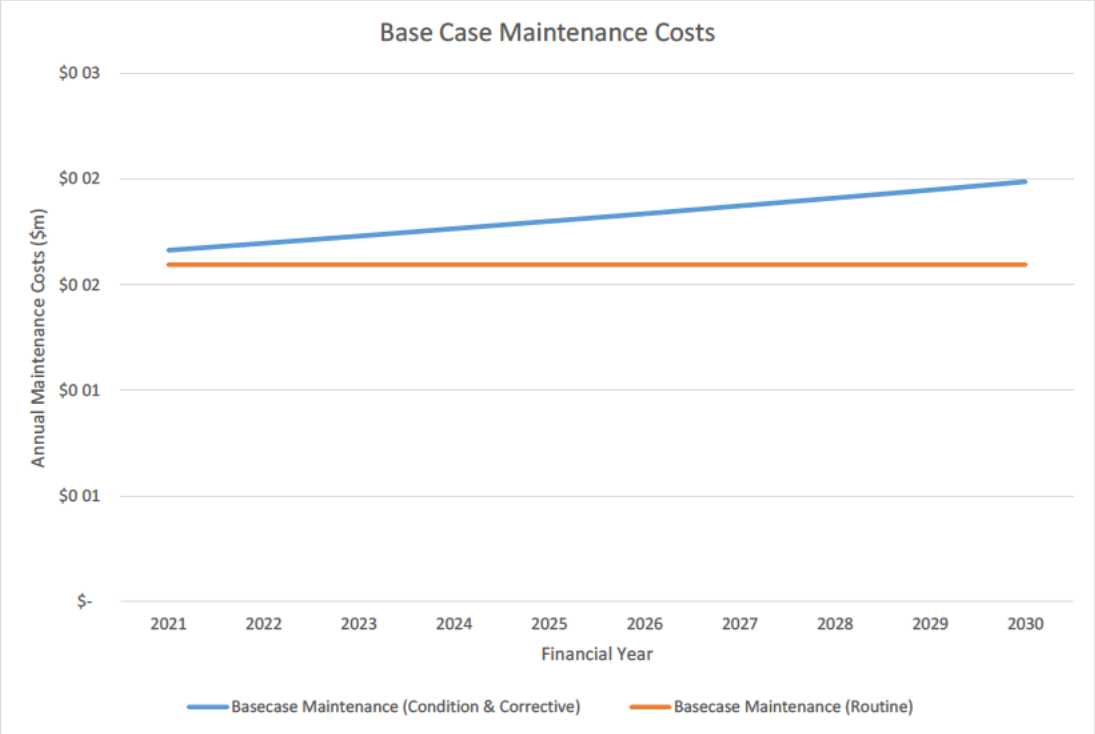


Figure 5 - Base case maintenance Costs 2021 - 2030

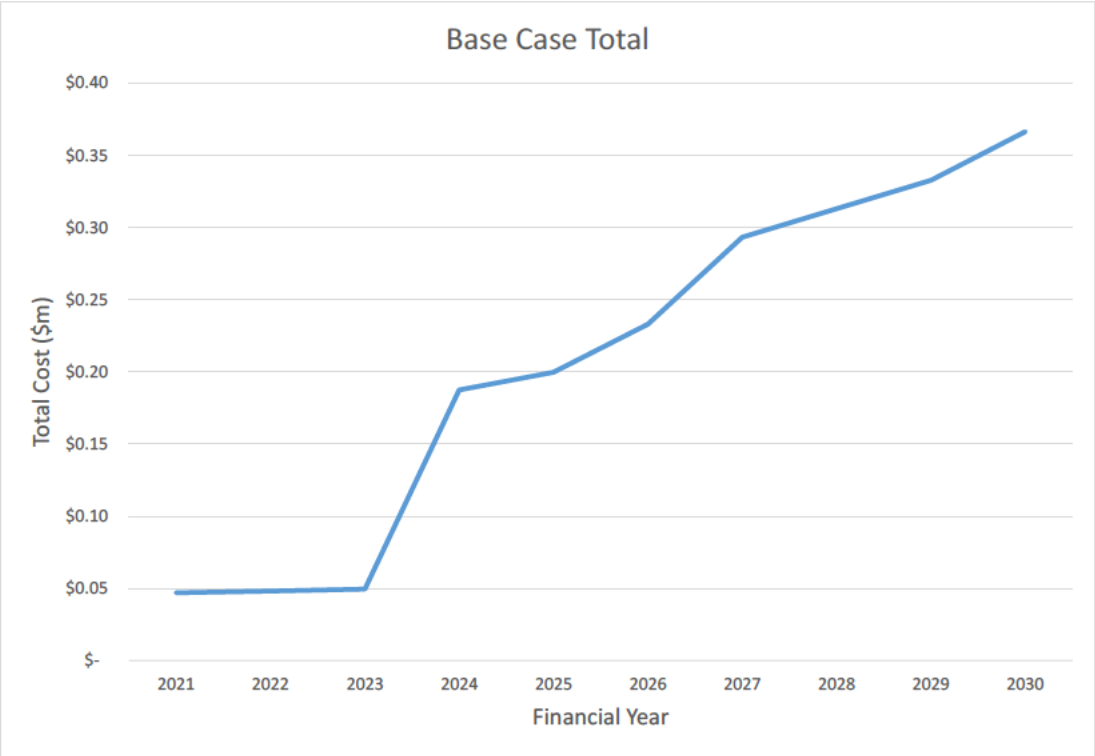


Figure 6 - Base case total costs (maintenance + risk cost) 2021 to 2030

5 Participation factors

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 30%. Hence, an increase in VCR of 100% would increase the overall risk cost by around 30%.

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 model is most sensitive to emergency replacement cost followed by plant restoration time for both pre-secondary systems obsolescence and post-secondary systems obsolescence states.

The sensitivity to assumptions on VCR is higher when secondary systems obsolescence is reached.

Table 2: Input values, secondary systems model

	Item	Value	Unit
Network	VCR	44346	$/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

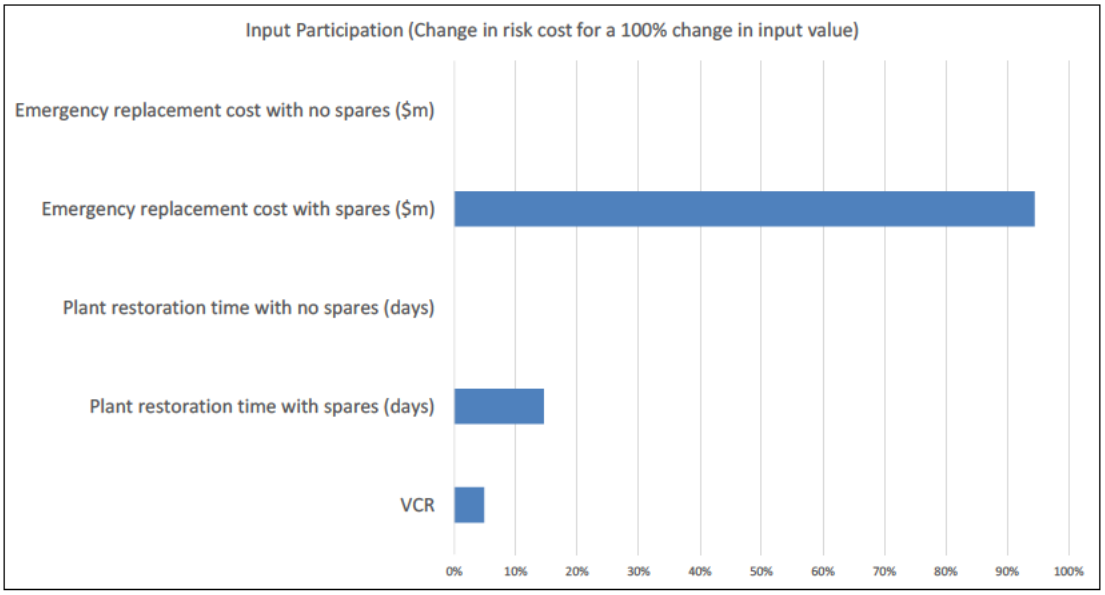


Figure 7 - Participation factors, secondary systems model – pre secondary systems obsolescence

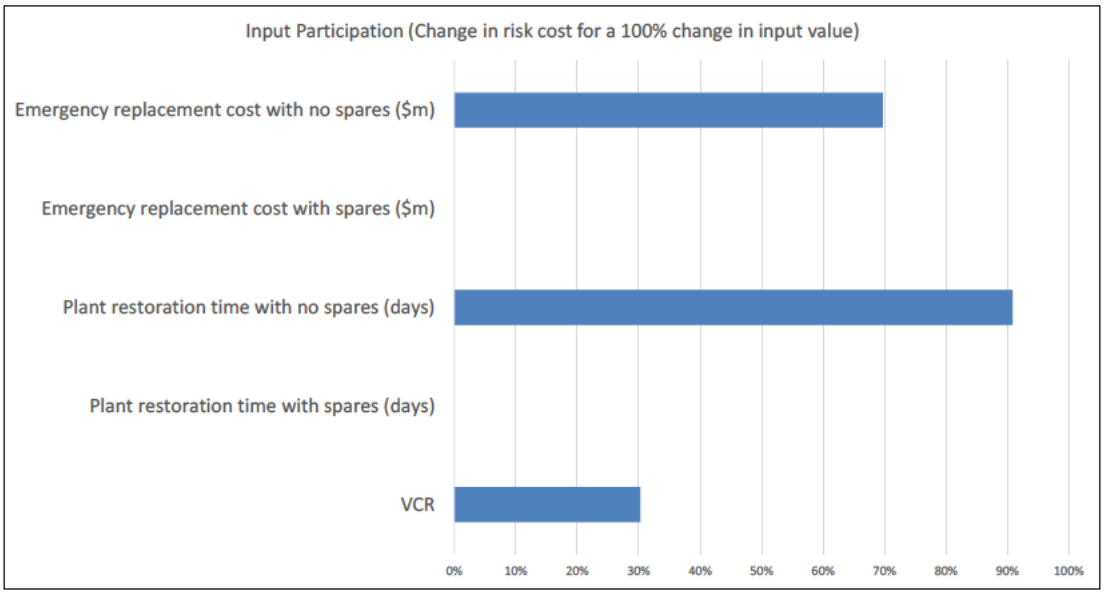


Figure 8 - Participation factors, secondary systems model – post secondary systems obsolescence

Project Scope Report

CP.02751

Murarrie Secondary System Replacement

Proposal – Version 1

Document Control

Change Record

Issue Date	Responsible Person	Objective Document Name	Background
04/06/2020	[redacted]	Project Scope Report CP.02751 Murarrie Secondary Systems Replacement	Initial version

Related Documents

Issue Date	Responsible Person	Objective Document Name

Project Contacts

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

Project Details

1. Project Need & Objective

Murarrie Substation is a 275/110kV substation located approximately 8km north-east of the Brisbane CBD. Established in 2003, the substation consists of both 275kV and 110kV bays within a common platform and a perimeter fence.

A recent condition assessment indicates that the secondary systems is reaching the end of its technical asset life and recommends staged replacement of the equipment between 2024 and 2027. In addition, discussions with operations teams have identified an operational need to ensure reliability of supply upon failure of either bus coupler, especially during the project's implementation. This can be achieved by reconfiguring 3 Transformer to be bus selectable between busses 1 and 3.

The objective of this project is to replace the secondary systems equipment, and reconfigure the connection of 3 Transformer, at Murarrie Substation by June 2027.

2. Project Drawing

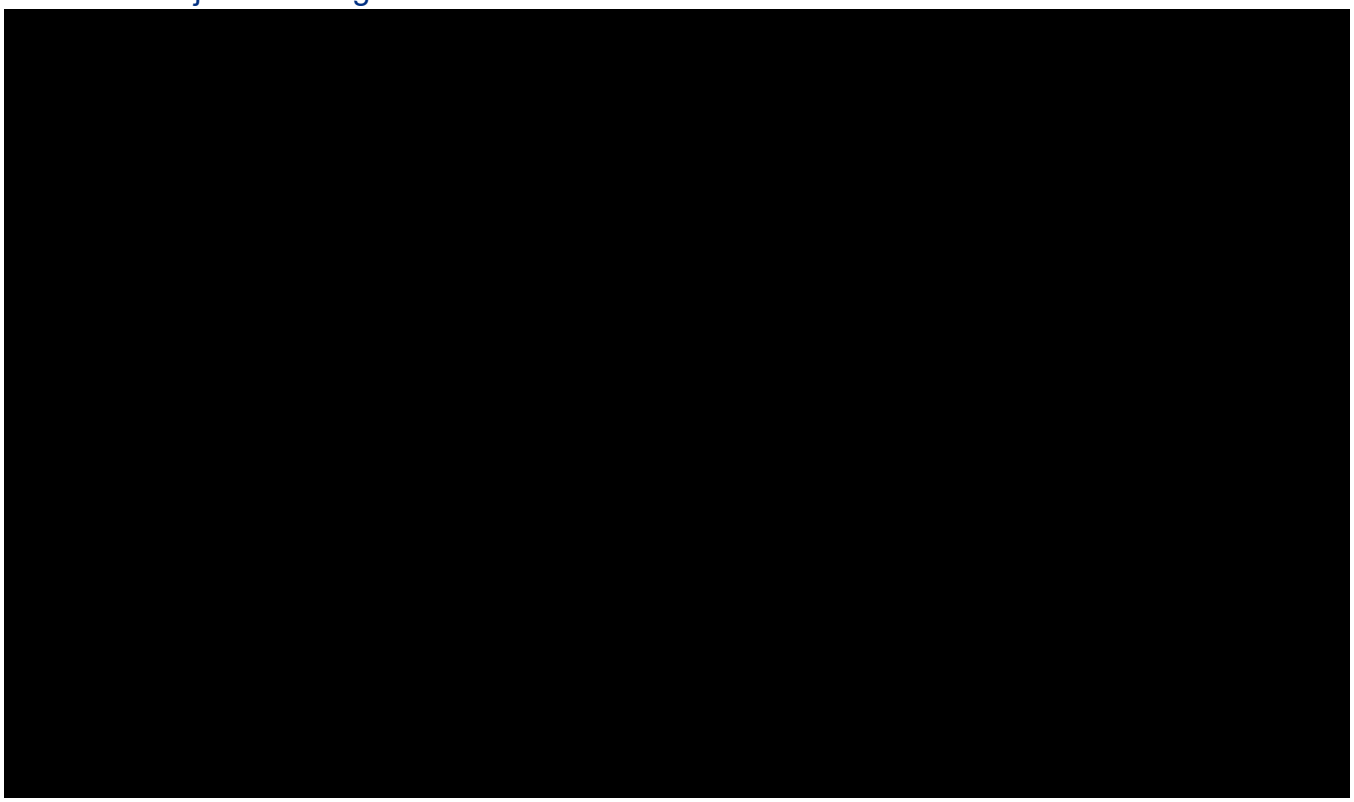


Figure 1 Murarrie Operating Diagram

Figure 2 Murarrie Locality Map

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 the replacement of the secondary systems equipment, and reconfiguration of 3 Transformer connections, at Murarrie Substation.

3.1.1. H021 Murarrie Substation Works

Design, procure, construct and commission in-panel replacement of the secondary systems relays and associated auxiliary components in preferred priority order outlined below.

Priority 1

- Replace the 110kV 1, 2 and 3 Bus Zone CBF Bus Trip Bus Zone RTU X and Y protection relays and Bay Control Unit;
- 1-2 Bus Section, 2-3 Bus Section X and Y protection relays and Bay Control Unit;
- Feeders 7270, 7271, 7272, 7273, 7274, 752, 753 X and Y protection relays and Bay Control Unit;
- Revenue metering on feeders 7270, 7274, 7288, 7271, 7272 & 753;
- Building +A Master LCF, Sub Interrogation NSC Links, timing System & Opswan;
- Building +B & +C LCF, Sub Interrogation Switch, Inverter and Opswan; and
- Building +T Opswan cameras and server, & common RTU.

Priority 2

- Reconfigure 3 transformer bay equipment to achieve remote transformer switching selectability between bus 1 and bus 3;
- Replace the T3 Transformer LV X and Y protection relays and Bay Control Unit;
- Replace the T3 Transformer HV X and Y protection relays, prot sig relays, and Bay Control Unit;
- Cap banks 2 and 3 X and Y protection relays, point on wave, and Bay Control Unit;
- Feeders 7287 and 7288 X and Y protection relays and Bay Control Unit;
- Feeder 830 X and Y protection relays, prot sig relays, comms and mux, and Bay Control Unit;
- Revenue metering on feeders 7273, 7287 & 752; and
- Building +5 LCF, OpsWAN including Converter & Inverter, timing system and RTU.

Priority 3

- Replace Feeder 8837 X and Y protection relays, prot sig relays, Comms and MUX, and Bay Control Unit;
- T2 Transformer LV X and Y protection relays, prot sig relays, and Bay Control Unit;
- T2 Transformer HV X and Y protection relays, and Bay Control Unit;
- Building +4 Common LCF, Inverter & Opswan.

In each phase of the work, decommission and recover all redundant equipment and update drawing records, SAP records, config files, etc. accordingly.

The reconfiguration of 3 transformer bay equipment to achieve remote transformer switching selectability between bus 1 and bus 3. The cost estimate for equipment shall be identified separately.

The timing of the following remote end works shall align to the timing of the associated works at Murarrie Substation.

3.1.2. SSLBS Lytton Substation Works

Modify protection, control, automation and communications systems for feeders 7270 and 7271.

3.1.3. SSDBS Doboy Substation Works

Modify protection, control, automation and communications systems for feeders 7272, 7273 and 7274.

3.1.4. H002 Belmont Substation Works

Modify protection, control, automation and communications systems for feeders 7287, 7288, 830 and 8837.

3.1.5. SSWRD Wellington Road Substation Works

Modify protection, control, automation and communications systems for teed feeders 7287 and 7288.

3.1.6. SSNSD Newstead Substation Works

Modify protection, control, automation and communications systems for feeders 752 and 753.

3.1.7. Key Scope Assumptions

Not applicable

3.1.8. Variations to Scope (post project approval)

Not applicable

4. Project Timing

4.1. Project Approval Date

The anticipated date by which the project will be approved is 31 July 2021 subject to satisfactory completion of the RIT-T.

4.2. Site Access Date

Murarrie is an existing Powerlink site. Access 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 June 2027.

Note that the latest completion dates for in-panel replacement of discrete equipment is by June 2027, however earlier completion dates per priority of the scope is identified.

5. Special Considerations

The following issues are important to consider during the implementation of this project:

- The staged in-panel replacement seeks to effect a minimum solution replacing only discrete control and protection equipment. Panel, cable and wiring replacement should only occur where necessary, with the basis for such changes documented. As such, the scope, staging and outage requirements shall be carefully workshopped.
- Any existing assets to be removed as part of this scope must be identified within the estimate together with the forecast asset write off amount at time of disposal.
- A high level project implementation plan including staging and outage plans should be considered and produced as part of the estimate.

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 & Business Development.

7. Asset Ownership

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

The asset boundary with Energy Queensland (Energex) is indicated on the operating diagram.

8. System Operation Issues

A project outage plan should be submitted in accordance with “Outage Management Process – Procedure (A463506)”, on form “Outage Plan – Projects (A523847)”. The Project Outage Plan must include both HV and Telecoms outages.

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

Project No.	Project Description	Planned Comm Date	Comment
Pre-requisite Projects			
Co-requisite Projects			
Other Related Projects			
CP.02319	Belmont 275kV Secondary System Replacement	30/06/2021	
OR.2252	Belmont Transformer T2 Decommissioning	30/06/2021	
OR.2253	Belmont Transformer T3 Decommissioning	30/06/2021	

CP.02751 – Murarrie Secondary System Replacement Project Management Plan

Record ID	A3403890	
Authored by	Project Manager	[redacted]
Reviewed by	Project Manager	[redacted]
Reviewed by	Team Leader	[redacted]
Approved by	Manager Projects	[redacted]

Note: Acceptance by Reviewers and Approver shall be managed using Objective.

Version History

Version	Date	Section(s)	Summary of amendment
1	31/08/2020	All	Document for Peer review
2	7/09/2020	All	Update from Estimate review meeting

Table of Contents

1. Executive Summary

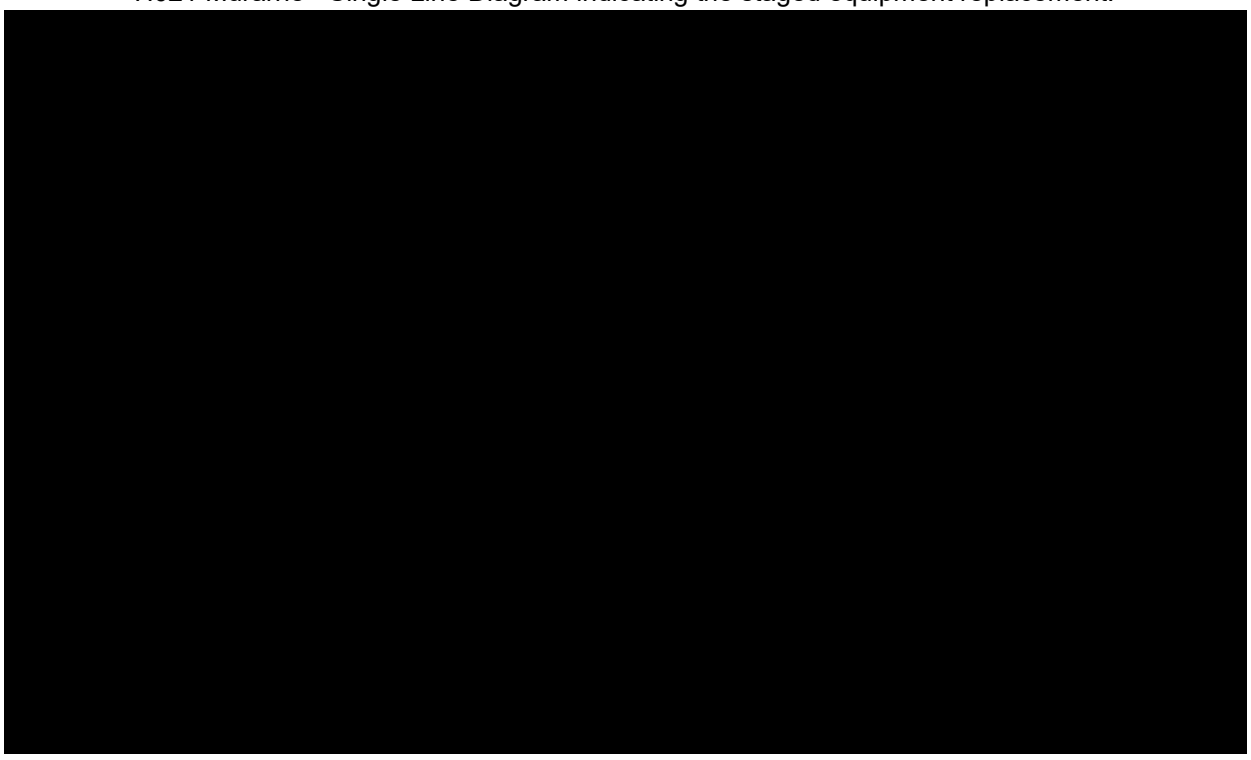
This proposal has been developed on the basis of the CP.02751 H021 Murarrie 110kV Secondary Systems Replacement Project Scope Report (PSR) – Proposal Version 1 (objective A3355409 and dated 04/06/2020).

Murarrie Substation is a 275/110kV substation located approximately 8km north-east of the Brisbane CBD. Established in 2003, the substation consists of both 275kV and 110kV bays sharing a common platform and a perimeter fence. The substation was built to supply power to Energy Queensland substations and Queensland Rail injection substation in the North East. There are 11 supplies to five remote ends that will require integration with the new secondary systems at H021 Murarrie under this project

A recent condition assessment indicates that the secondary systems is reaching the end of its technical asset life and requires replacement to ensure ongoing secure, reliable supplies and compliance with the National Electricity Rules. An operational requirement has also been identified to reconfigure the 110kV connection of Transformer 3 to be bus selectable between Bus 1 and 3. This will ensure the reliability of supply upon failure of either bus coupler and will enable the secondary systems works to be completed within the network outage constraints applicable to Murarrie Substation.

This proposal provides information and costs for the in-panel replacement of secondary systems relays and auxiliary equipment replacement at H021 Murarrie by a proposed commissioning date of June 2027. The requested date of December 2026 cannot be achieved due to the multiple staging and resource requirements.

H021 Murarrie - Single Line Diagram indicating the staged equipment replacement.



2. Project Definition

	Date
Project Scope Report (version 1) - date received	June 2020
Project Proposal and Project Estimate - date submitted	September 2020
Project Approval Advice (PAA) - date received	March 2021

2.1 Project Scope

The scope of works for the CP.02751 project is to reconfigure the 110kV HV connection of Transformer 3 to be bus selectable between Bus 1 and 3, to ensure the reliability of supply upon failure of either 110kV bus couplers and to complete an in-panel replacement of secondary systems relays and auxiliary equipment at H021 Murarrie by December 2026.

This proposal provides information and costs for the in-panel replacement of secondary systems relays and auxiliary equipment replacement at H021 Murarrie by June 2027. The requested date of December 2026 cannot be achieved due to the multiple staging and resource requirements.

2.1.1 Substations

At the time of development of this document the implementation of new CT links into existing PASS M0 Control cubicles has not been undertaken and the works is included in the scope of works to reduce the duration of the return to service and the required HV outages.

Design, procure, construct and commission the following:

- All Current Transformer (C/T) link terminals associated with C/T circuits, are to be replaced with a new physical disconnect terminal, as per Standards Update, SU0031. This costs for this works is included in the estimate.
- A new 110kV bay and corresponding panel shall be commissioned to convert T3 LV into a bus selectable arrangement between 1 Bus and 3 Bus.
- All existing X and Y relays and RTUs within Buildings A, B, C and +5 shall be replaced in situ, with the exception of the bus zone panels.

  This encompasses:

  - 2 x 275kV Feeder panels
  - 2 x 275kV Transformer panels
  - 9 x 110kV Feeder panels
  - 2 x Transformer LV panels (Note: one new T3 LV panel shall be installed under this project)
  - 2 x 110kV Capacitor Bank panels
  - 2 x 110kV Bus Coupler panels
  - The existing bus zone panels shall be converted to CT marshalling kiosks, and new bus zone panels shall be installed. Two new SIP/MPLS panels shall be installed. In addition, all existing metering and OpsWAN IEDs shall be replaced in situ. All field cabling shall be retained
  - Decommission and recover all redundant equipment and update records.

Remote End Substations

SSLBS Lytton Substation Works

- 110kV Feeders 7270 and 7271.
    - The existing secondary systems at SSDBS Lytton shall require modification to integrate with the new SDM8 system at H021 Murarrie;
    - These feeders are an Energy Queensland Asset. PLQ will be responsible for the Secondary Systems components at H021 end only;
    - Energy Queensland will be required to provide PLQ setting parameters for these feeders;
    - PLQ will free issue the relays to Energy Queensland; and
    - Modification of protection, control, automation and communications systems.

SSDBS Doboy Substation Works

- 110kV Feeders 7272, 7273 and 7274.
    - The existing secondary systems at SSDBS Doboy shall require modification to integrate with the new SDM8 system at H021 Murarrie;
    - These feeders are an Energy Queensland Asset. PLQ will be responsible for the Secondary Systems components at H021 end only;
    - Energy Queensland will be required to provide PLQ setting parameters for these feeder;
    - The 3 feeders are transformer ended and are only approximately 100 metres long;
    - PLQ will free issue these relays to Energy Queensland; and
    - Modification of protection, control, automation and communications systems.

H002 Belmont Substation Works

- 275kV Feeders 830 and 8837 and 110kV Feeders 7287and 7288,
    - The existing secondary systems at Belmont for these four feeders shall require modification to integrate with the new system at H021 Murarrie;
    - Feeder F7288 and F7287 to H003 Belmont Tee SSWRD Wellington Road (Energy Queensland) are PLQ asset;
    - PLQ will be responsible for the Secondary Systems components at H021 and H003 Belmont and shall provide settings only for Energy Queensland to implement at the Wellington Road end;
    - PLQ will free issue these relays to Energy Queensland; and
    - Modify protection, control, automation and communications systems.

SSWRD Wellington Road Substation Works

- 110kV Feeders 7287 and 7288.
    - Belmont-Murarrie 110kV feeders F7287 and F7288 have cable tees to SSWRD Wellington Road;
    - The existing secondary systems at SSWRD for these two feeders shall require modification to integrate with the new system at H021 Murarrie;
    - SSWRD Wellington Road is an Energy Queensland substation;
    - PLQ is to provide Energy Queensland with the required settings for the relays on Feeders F7287 & F7288, which are PLQ assets;
    - PLQ will free issue these relays to Energy Queensland; and
    - Modification of protection, control, automation and communications systems.

SSNSD Newstead Substation Works

- 110kV Feeders 752 and 753.
    - There are two 110kV feeders to SSNSD Newstead. The existing secondary systems at SSNSD shall require modification to integrate with the new system at H021 Murarrie;
    - These feeders are an Energy Queensland Asset;
    - PLQ will be responsible for the Secondary Systems components at H021 end only;
    - PLQ will free issue these relays to Energy Queensland; and
    - Energy Queensland will be required to provide PLQ setting parameters for these feeders

2.1.2 Transmission Lines / Transmission Lines Refit

Transmission Lines scope as follow:

- Nil works

2.1.3 Telecommunications

Telecommunication scope as follow:

- PLQ MSP to perform following works at H021 Murarrie in preparation for the secondary system cut overs:
    - Establish 2 X MPLS WAN interfaces between H021 and remote ends;
    - Perform RFC2544 Ethernet performance test for MPLS WAN interfaces; and
    - Test and commission 2 X MPLS LSRs at H021 provide communication system modifications for the substation work indicated above

2.1.4 Revenue Metering

The project includes the modification/replacement of revenue metering.

2.1.5 Other Project Works

Other categories of project works as follow:

- At the time of development of this document the implementation of SU0031 for the replacement of the CT terminal links into existing PASS M0 Control cubicles has not been undertaken but the works are required to reduce the duration of the required HV outages, and is therefore included in this project proposal.

2.2 Exclusions

Exclusions as follow:

- Replacement or modifications of the AC Changeover panel (ACCO);
- Any modifications to the existing AC power reticulation system and distribution boards;
- Any modifications to existing switchyard lighting;
- The existing power monitoring equipment was installed in 2016 and does not require replacement or alteration under this project;
- No marshalling kiosks shall be replaced under this project;
- All modifications to the existing PASS M0 and kiosks;
- No time allowance is included in the project schedule for any Energy Queensland projects that may impact PLQ schedule of works; and
- Any PASS M0 circuit breaker refurbishment / maintenance works.

2.3 Assumptions

Assumptions as follow:

- All network outages and durations will be acceptable to Network operations.
- The existing DC reticulation system shall be retained without modification;
- The existing time synchronisation system shall be retained, except for the Tekron clocks which shall be replaced;
- The existing fire and security systems shall be retained. Building +T shall remain as the designated point of entry to the site;
- The nine metering connections at Murarrie shall have the meters replaced in situ with SEL735 meters;
- Existing X99 fibre termination blocks shall be removed from all panels;
- The AC panel lighting system shall be replaced with a DC panel lighting system;
- The site's two OpsWAN cameras shall be replaced;
- Existing cables' cable sizing has been verified for suitability to be retained;
- The existing single combined 110kV/275kV OptoNet ring shall be replicated with new [redacted]
- A standard SDM8 AVR system shall be implemented in the Common RTU;
- New SIP/MPLS panels shall be installed in Building +5;
- The existing MK3 meters shall be replaced with [redacted] meters and two [redacted] shall be installed in each metering panel to facilitate IP metering;
- It is assumed that Energy Queensland Design and construction resources will be available when required and Energy Queensland has no project works scheduled that may impact on the PLQ schedule of works;
- The timely agreement of the Division Of Responsibility (DOR) between Energy Queensland and PLQ for all the works involved;
- Any PASS M0 circuit breaker refurbishment / maintenance works has been completed before the commencement of the project;
- Asset Management approval is granted for identified HV Plant to be installed in existing diameters =D24 and =D25. To create one transformer selectable bay these 2 diameters will be combined and only referred to as diameter =D25;
- The telecommunications equipment at H021 Murarrie was upgraded in 2014 and as the vendor has discontinued the product line. Alternate solutions are being looked at this time, an allowance has been included in the estimate to design for an unidentified future communication standard;
- An approved safe work method has been developed by the OSD support engineers to complete the replacement of C/T links;
- Asset Management approval is granted for RTS on single Protection scheme, if required;
- ABB relays shall be the Y protection and control IEDs under the period contract during Execution;
- Communication standards permit the SIP/MPLS panels to be located within the new 275kV control building +11 as there is no spare capacity within the existing telecommunications building +T;
- New Bus Zone CT and T3 Bay marshalling kiosks are still required;
- Civil works to be delivered by SPA contractor by a Construction / Test contract; and
- A Geotechnical investigation will be deemed necessary in the vicinity of the new HV plant support structures locations.

2.4 Project Interaction

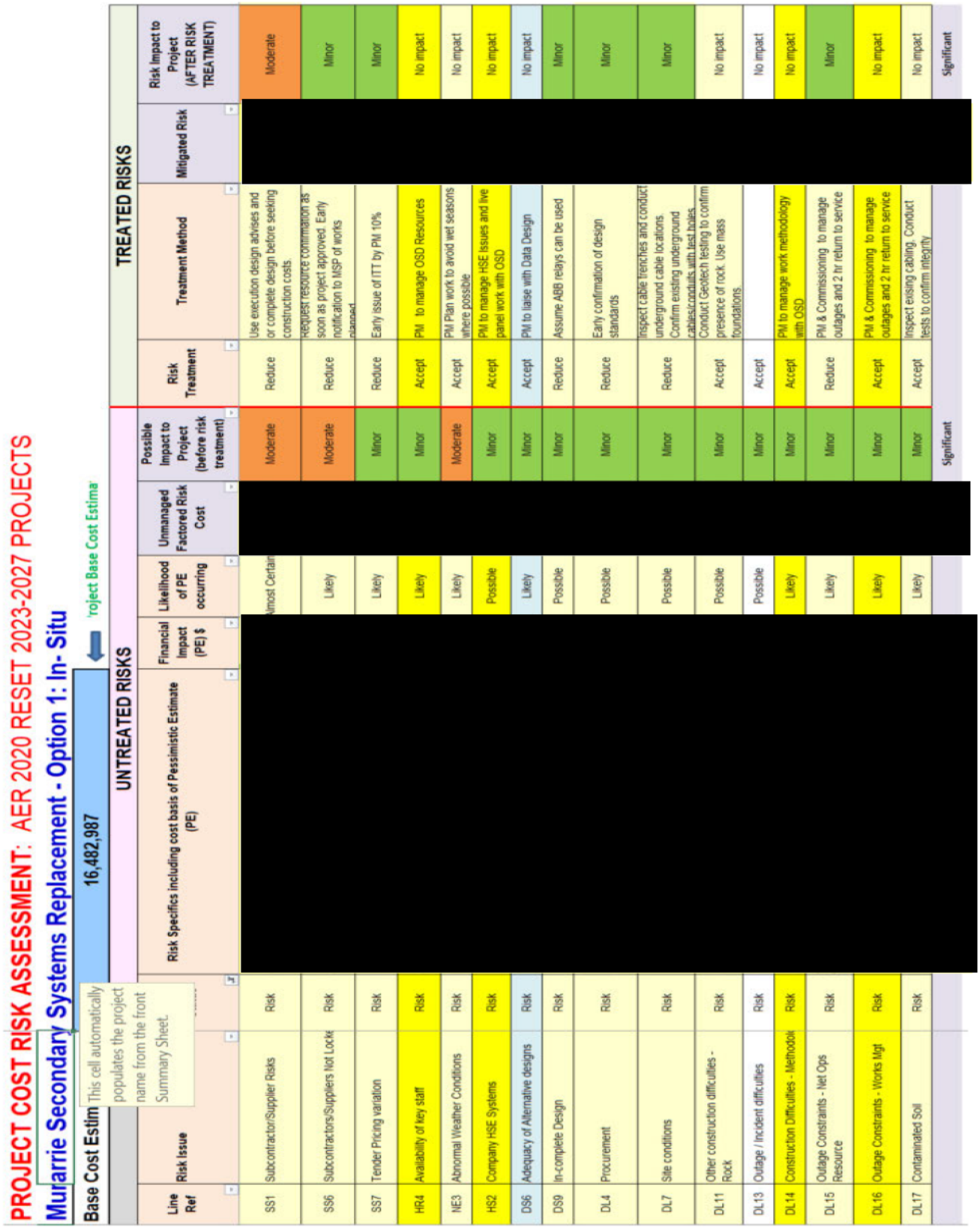
Interactions with other projects and Engineering Task Request (ETRs) as follow:

Project No.	Project Description	Planned Commissioning Date	Comment
Dependencies			
OR.02240	H021 Murarrie Bay =D029 Decommissioning	Feb 2020	Project works complete
Interactions			
CP.02319	Belmont Secondary System Replacement	June 2021	
Other Related Projects			
OR.02296	Murarrie to Virginia Microwave Decomm.	June 2020	

2.5 Project Risk

Un-escalated cost for Project risks identified during the Project Proposal phase are as follows.

During Project Execution, project risks are recorded managed in PWA Server.



PROJECT COST RISK ASSESSMENT: AER 2020 RESET 2023-2027 PROJECTS

Murarrie Secondary Systems Replacement - Option 1: In- Situ

Base Cost Estim 16,482,987 'roject Base Cost Estima'

This cell automatically populates the project name from the front Summary Sheet.

			UNTREATED RISKS						TREATED RISKS			
Line Ref	Risk Issue		Risk Specifics including cost basis of Pessimistic Estimate (PE)	Financial Impact (PE) $	Likelihood of PE occurring	Unmanaged Factored Risk Cost	Possible Impact to Project (before risk treatment)	Risk Treatment	Treatment Method	Mitigated Risk	Risk Impact to Project (AFTER RISK TREATMENT)
SS1	Subcontractor/Supplier Risks	Risk	[redacted]	[redacted]	Almost Certain	[redacted]	Moderate	Reduce	Use execution design advises and or complete design before seeking construction costs	[redacted]	Moderate
SS6	Subcontractors/Suppliers Not Lockir	Risk			Likely		Moderate	Reduce	Request resource commination as soon as project approved. Early notification to MSP of works planned		Minor
SS7	Tender Pricing variation	Risk			Likely		Minor	Reduce	Early issue of ITT by PM 10%		Minor
HR4	Availability of key staff	Risk			Likely		Minor	Accept	PM to manage OSD Resources		No impact
NE3	Abnormal Weather Conditions	Risk			Likely		Moderate	Accept	PM Plan work to avoid wet seasons where possible		No impact
HS2	Company HSE Systems	Risk			Possible		Minor	Accept	PM to manage HSE Issues and live panel work with OSD		No impact
DS6	Adequacy of Alternative designs	Risk			Likely		Minor	Accept	PM to liaise with Data Design		No impact
DS9	In-complete Design	Risk			Possible		Minor	Reduce	Assume ABB relays can be used		Minor
DL4	Procurement	Risk			Possible		Minor	Reduce	Early confirmation of design standards		Minor
DL7	Site conditions	Risk			Possible		Minor	Reduce	Inspect cable trenches and conduct underground cable locations. Confirm existing underground cables/conduits with test holes		Minor
DL11	Other construction difficulties - Rock	Risk			Possible		Minor	Accept	Conduct Geotech testing to confirm presence of rock. Use mass foundations		No impact
DL13	Outage / Incident difficulties	Risk			Possible		Minor	Accept			No impact
DL14	Construction Difficulties - Methodol	Risk			Likely		Minor	Accept	PM to manage work methodology with OSD		No impact
DL15	Outage Constraints - Net Ops Resource	Risk			Likely		Minor	Reduce	PM & Commissioning to manage outages and 2 hr return to service		Minor
DL16	Outage Constraints - Works Mgt	Risk			Likely		Minor	Accept	PM & Commissioning to manage outages and 2 hr return to service		No impact
DL17	Contaminated Soil	Risk			Likely		Minor	Accept	Inspect exising cabling. Conduct tests to confirm integrity		No impact
							Significant				Significant

3. Project Financials

3.1 Project Estimate

3.1.1 Estimate Summary

		Sub Total $	Total $
Estimate Class	3		
Estimate accuracy (+% / -%)	30% / - 20%		
Base Estimate (Un-escalated)		$16,482,987	
Escalation (Total escalation)		$2,434,229	
Estimate Allowance (Escalated)		$922,965	
Proposed Release Budget (escalated)			$19,899,526
Project Risk (Escalated)	[redacted]	[redacted]	
Contingency Allowance (Escalated)	[redacted]	[redacted]	
Total Risk			[redacted]
TOTAL			[redacted]

3.1.2 Asset Write-Off Table

CP.02751 Asset Write-off. Values current at 30th June 2021

Functional Location	Description	Asset	Subnumber	Book val.	Write-off %	Write-off Value	Currency
H021-SIN	SUBSTATION INFRASTRUCTURE - MURARRIE SUB	108121	0	3,035,026.46	2%	$ 60,700.53	AUD
H021-SSS-411-	110 kV 1 BUS SECTION BAY	108828	0	25,190.15	10%	$ 2,519.02	AUD
H021-SSS-412-	110 kV 1 BUS SECTION BAY	108829	0	25,190.15	10%	$ 2,519.02	AUD
H021-SSS-442-	110 kV 2 TRANSFORMER BAY (=D19)	113223	0	7,973.32	10%	$ 797.33	AUD
H021-SSS-443-	110kV 3 TRANSFORMER BAY	113221	0	7,973.32	10%	$ 797.33	AUD
H021-SSS-482-	110kV 2 CAPACITOR BAY	112184	0	21,387.93	10%	$ 2,138.79	AUD
H021-SSS-483-	110kV 3 CAPACITOR BAY	112185	0	21,387.91	10%	$ 2,138.79	AUD
H021-SSS-542-	275 kV 2 TRANSFORMER BAY (=C2)	117209	0	127,517.33	10%	$ 12,751.73	AUD
H021-SSS-543-	275kV 3 TRANSFORMER BAY	113222	0	13,679.71	10%	$ 1,367.97	AUD
H021-SSS-7270	7270 LYTTON 110 kV FEEDER BAY	108833	0	36,226.01	10%	$ 3,622.60	AUD
H021-SSS-7271	7271 LYTTON 110 kV FEEDER BAY	108834	0	36,226.01	10%	$ 3,622.60	AUD
H021-SSS-7272	7272 DOBOY 110 kV FEEDER BAY	108835	0	36,226.01	10%	$ 3,622.60	AUD
H021-SSS-7273	7273 DOBOY 110 kV FEEDER BAY	108836	0	36,226.01	10%	$ 3,622.60	AUD
H021-SSS-7274	7274 DOBOY 110 kV FEEDER BAY	108837	0	36,225.99	10%	$ 3,622.60	AUD
H021-SSS-7287	7287 BELMONT 110 kV FEEDER BAY	113224	0	8,981.75	10%	$ 898.18	AUD
H021-SSS-7288	7288 BELMONT 110 kV FEEDER BAY	113225	0	8,981.75	10%	$ 898.18	AUD
H021-SSS-752-	752 NEWSTEAD 110 kV FEEDER BAY	108831	0	36,226.01	10%	$ 3,622.60	AUD
H021-SSS-753-	753 NEWSTEAD 110 kV FEEDER BAY	108832	0	36,226.01	10%	$ 3,622.60	AUD
H021-SSS-830-	830 FEEDER BAY	113226	0	17,874.87	10%	$ 1,787.49	AUD
H021-SSS-8837	8837 FEEDER BAY (=C2)	117210	0	166,621.30	10%	$ 16,662.13	AUD
H021-SSS-METR-REVMET1	FDR 7270 ENERGY METERING (REVENUE)	108839	0	16,495.27	10%	$ 1,649.53	AUD
H021-SSS-METR-REVMET2	FDR 7271 ENERGY METERING (REVENUE)	108840	0	16,494.93	10%	$ 1,649.49	AUD
H021-SSS-METR-REVMET3	FDR 7272 ENERGY METERING (REVENUE)	109955	0	13,245.93	10%	$ 1,324.59	AUD
H021-SSS-METR-REVMET4	FDR 7273 ENERGY METERING (REVENUE)	109956	0	13,245.93	10%	$ 1,324.59	AUD
H021-SSS-METR-REVMET5	FDR 7274 ENERGY METERING (REVENUE)	109957	0	13,245.93	10%	$ 1,324.59	AUD
H021-SSS-METR-REVMET6	FDR 752 ENERGY METERING (REVENUE)	113227	0	777	10%	$ 77.70	AUD
H021-SSS-METR-REVMET7	FDR 753 ENERGY METERING (REVENUE)	113228	0	777	10%	$ 77.70	AUD
H021-SSS-METR-REVMET8	FDR 7287 ENERGY METERING (REVENUE)	113229	0	777	10%	$ 77.70	AUD
H021-SSS-METR-REVMET9	FDR 7288 ENERGY METERING (REVENUE)	113230	0	1,713.87	10%	$ 171.39	AUD
H021-SSS-NBAY	NON BAY	108838	0	317,811.05	10%	$ 31,781.11	AUD
					Total	170,793.07	AUD

3.2 Approved Released Budget

The approved release budget to execute the project is as follows:

	Total $	Control Management
Project Estimate (escalated)	$18,976,561	Project Manager
Project Allowance (escalated)	$ 922,965	Project Manager
Project Release Budget	$19,899,526	Project Manager

3.3 Planned Costs (Forecasted Cash Flow)

During Project Execution, project planned costs are managed in SAP.

Cash Flow Table	Unescalated	Escalated
	July 2020 Base Date	Completion
To June 2021	260,000	260,000
To June 2022	2,835,870	2,952,140
To June 2023	2,835,870	3,073,178
To June 2024	2,843,639	3,207,943
To June 2025	2,835,870	3,330,345
To June 2026	2,835,870	3,466,889
To June 2027	2,835,870	3,609,031
Total	**17,282,987**	**19,899,526**

Asset Class	Asset Life	Base $	Percentage
Secondary Systems	15	14,378,846	83%
Communications	15	1,249,544	7%
Transmission Line Refit	35	-	0%
Primary Plant	40	1,654,596	10%
Transmission Lines	50	-	0%
TOTAL		**17,282,987**	

4. Project Planning Strategy

4.1 Milestones

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

Milestones	Planned Dates
Stage 1 - Project Approval (issue of PAN)	April 2021
Stage 2 - Project Approval (issue of PAN)	January 2022
Design information from Energy Queensland	June 2021
Site Access - to carry out investigations, inspections, etc.	April 2021
Site Possession - to carry out construction works	August 2022
Energex works complete and ready for connection	Staged throughout
Project Commissioning Date	December 2026
Final Decommissioning	June 2027

4.2 Project Staging

The high level project staging are as follows:

High Level Schedule – PC Date 2026	
Project Approval – Stage 1	April 2021
Project Approval – Stage 2	January 2022
SPA DC contract awarded	April 2022
MSP FAT Panels	October 2022
SPA Mobilisation – Stage 1	October 2022
MSP mobilisation – Stage 1 - CT Terminal work	May 2023
MSP Mobilisation – HV works	May 2023
MSP Mobilisation	April 2024
MSP Mobilisation	April 2025
MSP Mobilisation	April 2026
Project Commissioning Date	December 2026
Final Decommissioning and Recovery	June 2027

For detail staging, refer to the Project Staging Plan.

4.3 Project Schedule

Project timing shall be managed using a Project Schedule. Refer to the Project Schedule in PWA Server.

4.4 Network Impacts and Outage Planning

An Outage Plan was derived as part of the project proposal on the likelihood of the outages required for this project. This outage has been submitted to Network Operations. Network Operations have advised of the following known outage restrictions.

Network Outage requirements

- H021 Murarrie and H003 Belmont Transformers cannot be OOS at the same time;
- Load at Risk – Brisbane CBD;
- Return to Service constraint of 2 hrs at H021 Murarrie cannot be met. Refer Note Below;
- Outages to be scheduled in shoulder and winter periods - Late April/ May to October; and
- Detailed Restoration plans for every outage

NOTE: *Unless the Network operations constraint of 2hr RTS for network outages at H021 Murarrie substation can be negotiated with Energy Queensland to be extended to 10 – 12 hrs, this project cannot proceed as planned. The Project Team is currently investigating this restriction.*

4.5 Project Delivery Strategy

Strategy to deliver the project as follows:

Description	***Responsibility***							
	Main Site				***Remote End(s)***			
	Powerlink	***Contractor***	***MSP (OSD)***	***MSP (Other)***	***Powerlink***	***Contractor***	***MSP (OSD)***	***MSP (Other)***
Primary Design Systems (PSD):								
Civil and Structural	☒	☐	☐	☐	☐	☐	☐	☐
Electrical	☒	☐	☐	☐	☐	☐	☐	☐
Secondary Systems Design (SSD):								
Protection	☒	☐	☐	☐	☐	☐	☐	☐
Automation (Circuitry and Systems Configurations)	☒	☐	☐	☐	☐	☐	☐	☐
Telecommunication System Design (TSD):								
Data Networks	☒	☐	☐	☐	☐	☐	☐	☐
Construction:								
Civil	☐	☒	☐	☐	☐	☐	☐	☐
Construction (support structures, plant and equipment installation and demolition Works)	☐	☒	☐	☐	☐	☐	☐	☐
Secondary Systems Installation (loose panels installation, panel modification, IED replacement, etc.)	☐	☐	☒	☐	☐	☐	☐	☐
Telecommunication Construction (including fibres)	☐	☒	☐	☐	☐	☐	☐	☐
Testing and Commissioning:								
Factory Acceptance Test	☐	☐	☒	☐	☐	☐	☐	☐
Site Acceptance Test (partial)	☐	☐	☒	☐	☐	☐	☐	☐
System Cut Over and Commissioning	☐	☐	☒	☐	☐	☐	☐	☐

Description	Responsibility							
	Main Site				Remote End(s)			
	Powerlink	Contractor	MSP (OSD)	MSP (Other)	Powerlink	Contractor	MSP (OSD)	MSP (Other)
Other:								
Revenue Metering site works	☐	☐	☒	☐	☐	☐	☐	☐

4.6 Procurement Strategy

The procurement strategy for services and selected items are listed below. All other services and items shall be procured in accordance with Powerlink's Procurement Standard.

Description	Procurement Method
Services:	
SPA – DCT	ITT - Substation Panel Arrangement (SPA)
Optical Fibre System	Short-form ITT – Standing Offer arrangement with preferred/preapproved suppliers
MSP	RFQ
Primary Plant and Equipment:	
HV Plant and Equipment	Period Contractors
Structures	ITT – Standing Offer arrangement with preferred/preapproved suppliers
Hardware and fittings	ITT – Standing Offer arrangement with preferred/preapproved suppliers
Secondary Systems Equipment:	
IEDs	Period Contract
Panels, Kiosks, Boards and building fit-out	Short-form ITT – Standing Offer arrangement with preferred/preapproved suppliers
Fire System	Standing Offer arrangement with preferred/preapproved suppliers
Security System	Standing Offer arrangement with preferred/preapproved suppliers