APD ENGINEERING

MOORABOOL TERMINAL STATION

TRANSMISSION REVENUE RESET (TRR) PROJECT SCOPING

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EXECUTIVE SUMMARY

AusNet Services engaged APD Engineering to prepare project scopes and estimates relating to options for replacement of primary and secondary equipment at Moorabool Terminal Station (MLTS) for inclusion in AusNet Services' 2022 – 2027 Transmission Revenue Reset.

APD Engineering has reviewed a functional scope prepared by AusNet Services and developed detailed scopes and estimates for each planning option required by AusNet Services.

In undertaking this scoping work, APD Engineering has assessed that the options appear credible and can be constructed through the development of a possible construction sequencing that limits the risk of interruption to supply to the load connected to Geelong Terminal Station.

The planning options considered, along with the associated costs, are included in Table 1 below. These costs exclude contingency but include an allowance for overheads and finance charges. The cost estimates have an accuracy of ±30%.

Option	Option Title	Capital cost (M)
1	Integrated Project	$19.01
2	500kV Switchgear replacement	$12.87
3	220kV Switchgear replacement	$6.24

Table 1 - Estimated Capital Costs

[C-I-C]
DESIGN MANAGER

1. INTRODUCTION

AusNet Services engaged APD Engineering in prepare a project scopes and estimates relating to options for replacement of primary and secondary equipment at Moorabool Terminal Station (MLTS) for inclusion in AusNet Services' 2022 – 2027 Transmission Revenue Reset.

AusNet Services requested that APD Engineering provides high level estimates for replacement projects only. Where a refurbishment option is presented in the functional requirements, AusNet Services will estimate the cost of refurbishment.

AusNet Services has identified that parts of the 500kV and 220kV switchyard is in poor condition and presents a risk of failure. AusNet Services has provided a functional scope outlining the equipment condition assessments and outlining possible options for replacement.

Scoping for the primary and secondary equipment replacement, along with planning options for consideration as per reference [1] – Moorabool Terminal Station (MLTS) Circuit Breaker Replacement Project TD-0006168 are considered in this report.

2. LIMITATIONS

In preparing this report, APD Engineering has relied on information provided by AusNet Services, including (but not limited to):

1. Site drawings and documentation outlining the existing equipment on site;

2. Condition assessments and functional scopes identifying poor condition primary and secondary assets for replacement prepared by AusNet Services, along with supporting information to allow the development of the scopes and estimates;

3. A top down estimating spreadsheet provided by AusNet Services to calculate the capital costs associated with each project;

4. Unit costs for major items of plant and equipment, labour costs and other costs assumptions provided by AusNet Services as part of the top down estimating spreadsheet.

3. ASSUMPTIONS

The following assumptions have been made in preparing the scopes and estimates for this report.

1. No allowance has been made for telecommunications replacement.

2. It is assumed that, where required, the existing 415 VAC and 250VDC equipment can be modified as part of the project. Replacement of the full 415V AC/ 250VDC or 48VDC distribution boards and batteries has not been considered.

3. It is assumed that SCIMS hardware can be modified as part of the project. Only modification to existing SCIMS equipment has been included in the estimates. Full replacement of the RTU/SCIMS alarm modification or panel replacement has not been considered.

4. Allowance has been made to replace all Condition 4 and Condition 5 relays, including relays older than 9 years under Condition 2 and 3.

4. OPTION 1 – INTEGRATED PROJECT

4.1 OUTLINE OF PROJECT

This planning option delivers a single integrated project undertaking all works required to replace poor condition assets at Moorabool Terminal Station.

4.2 500KV WORKS

AusNet Services identified the need to replace eight 500kV circuit breakers in poor condition. In addition, there are a number of instrumentation transformers, isolators and earth switches within the 500kV switchyard. APD Engineering believes that the circuit breakers can be replaced in-situ with associated outages.

Figure 1 identifies the 500kV assets to be replaced as part of this project.

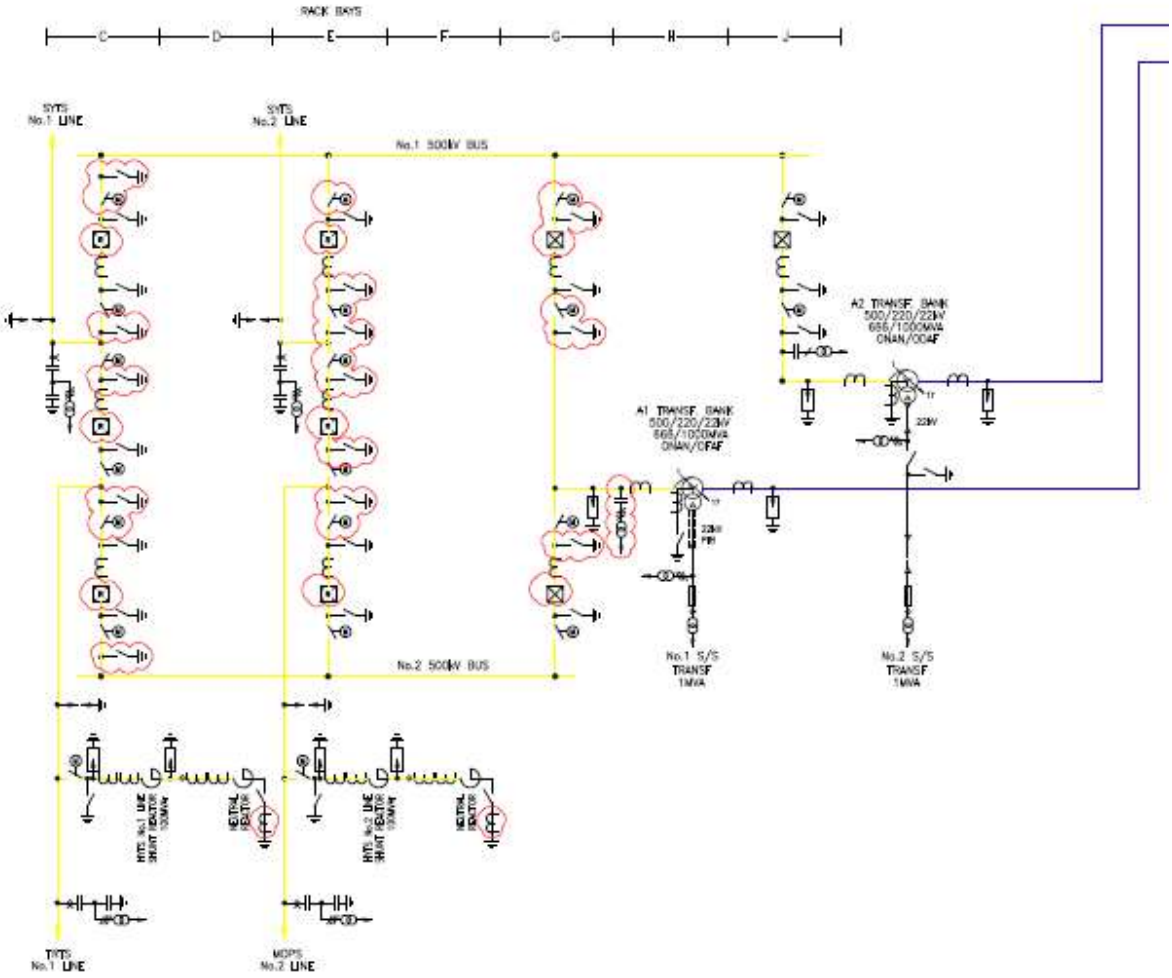

Figure 1 - MLTS 500kV SLD showing assets for replacement

A detailed scope of works has been prepared for the 500kV primary and secondary replacement to allow capital cost estimation. This scope has been included in scope in Appendix A

4.3 220KV WORKS

AusNet Services identified the need to replace ten 220kV circuit breakers that are in poor condition. In addition, there are a number of instrumentation transformers, isolators and earth switches within the 220kV switchyard. APD Engineering believes that the circuit breakers can be replaced in-situ with associated outages.

Figure 2 identifies the 220kV assets to be replaced as part of this project.

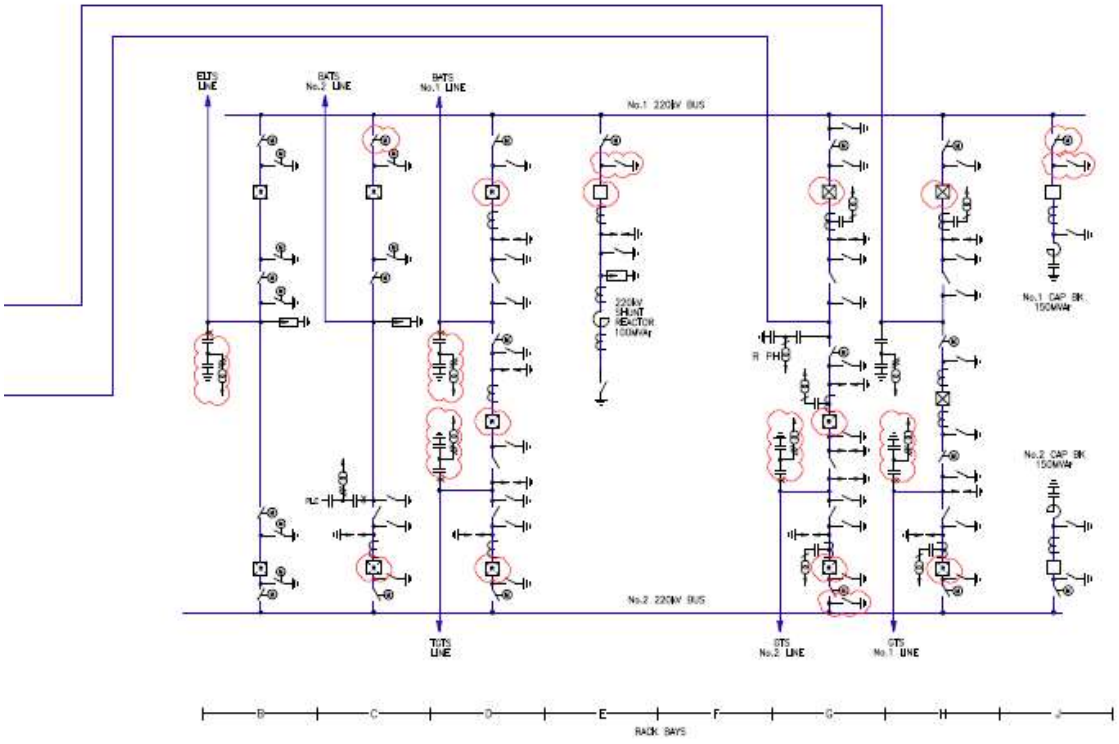

Figure 2 - 220kV SLD showing the assets to be replaced

A detailed scope of works has been prepared for the 220kV primary and secondary replacement to allow capital cost estimation. This scope has been included in scope in Appendix B

4.3.1 PLANNING ESTIMATE

The cost to implement the above project scope of work as an integrated project in has been estimated using the AusNet Services estimating spreadsheet at a total capital cost of $19.01M (±30%).

These costs exclude contingency but include an allowance for overheads and finance charges.

5. OPTION 2 – STAGED REPLACEMENT

5.1. OUTLINE OF PROJECT

This option requires the separation of the 500kV and 220kV switchgear into separate projects undertaken independently.

To facilitate the scoping and estimating, each project of work has been scoped separately and then combined to prepare each estimate.

5.2. PLANNING ESTIMATES

Based on the scopes in Appendix A and Appendix B, each project option has been estimated using the AusNet Services estimating spreadsheet. Table 2 below outlines the capital cost (±30%) for each project option proposed by AusNet Services.

Option	Option Title	Capital Cost (M)
2	500kV Switchgear replacement	$12.87
3	220kV Switchgear replacement	$6.24

Table 2 – Capital Cost for each project option

These costs exclude contingency but include an allowance for overheads and finance charges.

6. REFERENCES

The following document were applied in preparation of this report.

TYPE	OWNER	TITLE
Document	AusNet	Moorabool Terminal Station (MLTS) –Circuit Breaker Replacement Project TD-0006168
Document	AusNet	Top-down Transmission Estimate for Option Selection Rev 2.7
Document	AusNet	Relays Condition Score Status as off 07.05.2019
Drawing	AusNet	Moorabool Terminal Station 220kV and 500kV Single Line Diagram – T14/31/206

APPENDIX A.

500kV switchyard Switchgear replacement primary and secondary works within MLTS includes the following primary and secondary assets replacement.

APPENDIX A.1.

The primary scope to replace selected 500kV equipment.

500kV Bay	**Activity**	**Description (Primary Equipment)**
Bay C (SYTS1)	Remove	Existing SYTS1 500kV No.1 bus CB (FA4 525kV 4000A 3 x 1ϕ)
	Install	- Install one off new SYTS1 500kV No.1 bus LTCB
	Remove	Existing SYTS 1 500kV line No.1 Bus CB Bus side ROI Existing SYTS 1 500kV line No.1 Bus CB line side E/SW Existing SYTS 1 500kV line No.1 Bus CB Bus side E/SW

	Install	Install one off new SYTS 1 500kV line No.1 Bus CB Bus side ROI - Including 2 x integrated earth switch
Bay C (TRTS 1)	Remove	Existing TRTS1 500kV line No.2 Bus CB (FA4 525kV 4000A 3 x 1ϕ)
	Install	Install one off new TRTS1 500kV line No.2 bus LTCB
	Remove	Existing TRTS1/SYTS 1 500kV CB (FA4 525kV 4000A 3 x 1ϕ)
	Install	Install one off new TRTS1/SYTS 1 500kV LTCB
Bay C	Remove	Existing TRTS 1/SYTS 1 Line CB TRTS No.1 Line side ROI Existing TRTS 1/ SYTS 1 Line CB SYTS No.1 Line side E/SW Existing TRTS 1 500kV line No.2 Bus CB Bus side E/SW Existing TRTS 1 500kV line No.2 Bus CB line side E/SW
	Install	Install one off new TRTS 1/SYTS 1 Line CB TRTS No.1 Line side ROI - Including 2 x integrated earth switch
Bay C	Remove	Existing TRTS 1 500kV Line Shunt Reactor Neutral CT
	Install	- Install new one-off single phase TRTS 1 500kV Line Shunt Reactor Neutral CT
Bay E (SYTS 2)	Remove	Existing SYTS 2 500kV No.1 bus CB (FA4 525kV 4000A 3 x 1ϕ)
	Install	- Install one off new SYTS 2 500kV No.1 bus LTCB
	Remove	Existing SYTS 2 500kV line No.1 Bus CB Line side ROI Existing SYTS 2 500kV line No.1 Bus CB Bus side ROI Existing SYTS 2 500kV line No.1 Bus CB line side E/SW Existing SYTS 2 500kV line No.1 Bus CB Bus side E/SW
	Install	Install one off new SYTS 2 500kV line No.1 Bus CB Bus side ROI - Including 1 x integrated earth switch
		Install one off new SYTS 2 500kV line No.1 Bus CB Line side ROI - Including 1 x integrated earth switch
	Remove	Existing MOPS 2 500kV No.2 bus CB (FA4 525kV 4000A 3 x 1ϕ)
	Install	- Install one off new MOPS 2 500kV No.2 Bus LTCB
	Remove	Existing MOPS 2 / SYTS 2 500kV CB (FA4 525kV 4000A 3 x 1ϕ)
	Install	- Install one off new MOPS 2 / SYTS 2 500kV LTCB

	Remove	Existing MOPS 2 500kV line No.2 Bus CB Line side ROI Existing MOPS 2 500kV line No.2 Bus CB line side E/SW Existing MOPS 2/ SYTS 2 line CB SYTS No.2 Line side ROI Existing MOPS 2/ SYTS 2 500kV line CB SYTS No.2 Line side E/SW Existing MOPS 2/ SYTS 2 500kV line CB MOPS No.2 Line side E/SW
	Install	Install one off new MOPS 2 500kV line No.2 Bus CB Line side ROI - Including 1 x integrated earth switch
		Install one off new MOPS 2/ SYTS 2-line CB SYTS No.2 Line side ROI - Including 2 x integrated earth switch
	Remove	Existing MOPS 2 500kV Line Shunt Reactor Neutral CT (Tyree)
	Install	- Install new one-off MOPS 2 500kV Line Single Phase Shunt Reactor Neutral CT
Bay G (A1 TRANSF)	Remove	Existing A1 TR No.1 Bus 500kV CB (FA4 525kV 4000A 3 x 1ϕ)
	Install	- Install one off new A1 TR No.1 Bus 500kV LTCB
	Remove	Existing A1 TR No.2 Bus 500kVCB (FA4 525kV 4000A 3 x 1ϕ)
	Install	- Install one off new A1 TR No.2 Bus 500kVLTCB
	Remove	Existing A1 500/220kV TRANS 500kV CVT R/PH & B/PH
	Install	Install a new A1 500/220kV TRANS 500kV VT "R, W, B" Phase - Including 3 x Single Phase Post Type 500kV CVT
	Remove	Existing A1 Trans No.1 Bus 500kV CB Trans Side ROI Existing A1 Trans No.1 Bus 500kV CB Trans side E/SW Existing A1 Trans No.2 Bus 500kV CB Trans Side E/SW Existing A1 Trans No.1 Bus 500kV CB Bus Side ROI Existing A1 Trans No.1 Bus 500kV CB Bus side E/SW Existing A1 Trans 500kV E/SW

	Install	Install one off new A1 Trans No.1 Bus 500kV CB Trans side ROI - Including 1 x integrated earth switch
		Install one off new A1 Trans No.1 Bus 500kV CB Bus side ROI - Including 2 x integrated earth switch

APPENDIX A.2.

The secondary scope to replace selected 500kV equipment.

500kV Bay	Activity	Description (Secondary Equipment)
Bay C (SYTS1)	Remove	Existing SYTS 1 Protection & control Scheme - SYTS1 Y Digital Current diff/dist Relay
	Install	- Install new SYTS 1 Y Protection & control Scheme. - Install new SYTS 1 Y Protection & control Scheme to Remote end
Bay C (TRTS 1)	Remove	Existing of TRTS1 Y Overvoltage Relay - TRTS1 Y Overvoltage Relay
	Install	- Install new one-off TRTS1 Y Overvoltage Relay
Bay E (SYTS 2)	Remove	Existing SYTS 2 Y Protection & control Scheme - SYTS2 Y Digital Current diff/dist Relay
	Install	- Install one off new SYTS 2 Y Protection & control Scheme - Install new SYTS 2 Y Protection & control Scheme to Remote end
Bay E (MOPS 2)	Remove	Existing MOPS 2 Y Overvoltage Relay - MOPS 2 Y Overvoltage Relay
	Install	- Install new one-off MOPS 2 Y Overvoltage Relay
Bay J A2 Trans	Remove	Existing A2 Transformer Protection & control Scheme - A2 TR Y Overvoltage Relay P922 - A2 TR X Diff Prot Relay DBM - A2 TR Y Fault Diff Prot Relay - A2 TR Y LV Zone Diff Prot Relay - Relay, P141, Current Check - A2 TR 220 1B CB BU CB Fail Prot & Cont - GTS1/A2 TR 220 CB BU CB Fail Prot & Cont - A2 TR Control Relay T2E Y - A2 TR Control Relay T2E X

		- A2 TR 1B 220 CB Control/Monitor Relay - A2 TR 1B 500 CB Control/Monitor Relay
	Install	- Install new A2 Transformer X& Y Protection & control Scheme - Install new A2 Transformer 1B 220 CB management Protection Scheme - Install new A2 Transformer 1B 500 CB management Protection Scheme
Common Panels	Remove	Existing Station Control & Monitor Relays - #1 SCIMS Alarm Control Relay T2E - #2 SCIMS Alarm Control Relay T2E - #3 SCIMS Alarm Control Relay T2E - #4 SCIMS Alarm Control Relay T2E
	Install	Install one off new Control & Monitor Relays - #1 SCIMS Alarm Control Relay - #2 SCIMS Alarm Control Relay - #3 SCIMS Alarm Control Relay - #4 SCIMS Alarm Control Relay

APPENDIX B.

APPENDIX B.1.

The primary scope to replace the selected 220kV equipment

220kV	Activity	Description (Primary Equipment)
Bay B (ELTS)	Remove	Existing ELTS 220kV Line CVT R/Phase Existing ELTS 220kVLine CVT W/Phase Existing ELTS 220kVLine CVT B/Phase
	Install	- Install a new three -off single phase 245kV CVT for ELTS 220kV Line "R, W, B" Including 3 x Single Phase Post Type 245kV CVT
Bay C (BATS 2)	Remove	Existing BATS 2 220kV Line No.2 Bus CB
	Install	Install one off new BATS 2 220kV line No.2 Bus CB
	Remove	Existing BATS 2 220kV L No.2 Bus CB CT R, W, B Phase
	Install	- Install one off new BATS2 220kV Line No.2 Bus CB CT R, W, B Phase
Bay D (BATS 1) (TGTS)	Remove	Existing BATS 1 220kV Line No.1 Bus CB Existing BATS 1/TGTS 220kV CB Existing TGTS 220kV Line No.2 Bus CB
	Install	- Install one off new BATS 1 220kV Line No.1 Bus CB - Install one off new BATS 1/TGTS 220kV CB - Install one off new TGTS 220kV Line No.2 Bus CB
	Remove	Existing BATS 1 220kV Line CVT R/Phase Existing BATS 1 220kV Line CVT W/Phase Existing BATS 1 220kV Line CVT B/Phase
	Install	Install a new three -off single phase 245kV CVT for BATS 1 220kV Line "R, W, B"

		- Including 3 x Single Phase Post Type 500kV CVT
	Remove	Existing TGTS 220kV Line CVT R/Phase Existing TGTS 220kV Line CVT W/Phase Existing TGTS 220kV Line CVT B/Phase
	Install	Install a new three -off single phase 245kV CVT for TGTS 1 220kV Line "R, W, B" - Including 3 x Single Phase Post Type 245kV CVT
	Remove	Existing BATS 1 220kV line No.1 Bus CB side ROI
	Install	- Install one off new BATS 1 220kV line No.1 Bus CB Bus side ROI
	Remove	Existing BATS1 220kV line No.1 Bus CB CT R, W, B phase Existing BATS1/TGTS 220kV line No.1 Bus CB CT R, W, B phase Existing TGTS 220kV Line No.2 Bus CB CT R, W, B Phase
	Install	- Install three off new single phase BATS1 220kV line No.1 Bus CB CT R, W, B - Install three off new single phase BATS1/TGTS 220kV line No.1 Bus CB CT R, W, B phase - Install three off new single phase TGTS 220kV Line No.2 Bus CB CT R, W, B Phase
Bay E	Remove	Existing 220kV Shunt Reactor CB
	Install	Install one off new 220kV Shunt Reactor CB
	Remove	Existing 220kV Shunt Reactor CB side ROI
	Install	- Install one off new 220kV Shunt Reactor CB side ROI
	Remove	Existing 220kV shunt reactor CB CT W/PH
	Install	- Install three off new single-phase Shunt Reactor CB CT R, W & B phase
Bay G (A1 TR)	Remove	Existing A1 TR No.1 Bus 220kV CB Existing GTS 2 /A1 TR 220kV CB

		Existing GTS 2 220kV line No.2 Bus CB
	Install	Install one off new A1 TR No.1 Bus 220kV CB Install one off new GTS 2 /A1 TR 220kV CB Install one off new GTS 2 200kV line No.2 Bus CB
	Remove	Existing GTS 2 220kV Line CVT R/Phase Existing GTS 2 220kV Line CVT W/Phase Existing GTS 2 220kV Line CVT B/Phase
	Install	Install a new three -off single phase 245kV CVT for GTS 2 220kV Line "R, W, B" - Including 3 x Single Phase Post Type 245kV CVT
	Remove	Existing GTS 2 220kV line No.2 Bus CB side ROI
	Install	- Install one off new GTS 2 220kV line No.2 Bus CB Bus side ROI
	Remove	Existing A1 TR No.1 Bus 220kV CB CT R, W, & B Phase
	Install	- Install three off new single-phase A1 TR No.1 Bus 220kV CB CT R, W, & B Phase
	Remove	Existing GTS 2 220kV L2 Bus CB CT R, W, B phase Existing GTS2 L/A1 TR 220kV CB CT R, W, B phase
	Install	- Install three off new single-phase GTS 2 220kV L2 Bus CB CT R, W, B phase - Install three off new single phase GTS2 L/A1 TR 220kV CB CT R, W, B phase
Bay H (A2 TR) (GTS 1)	Remove	Existing A2 TR No.1 Bus 220kV CB Existing GTS 1 220kV Line No.2 Bus CB
	Install	- Install one off new A2 TR No.1 Bus 220kV CB - Install one off new GTS 1 220kV Line No.2 Bus CB
	Remove	Existing GTS 1 220kV Line CVT W/Phase Existing GTS 1 220kV Line CVT B/Phase

		Existing GTS1 220kV Line CVT R/Phase
	Install	- Install a new three -off single phase 245kV CVT for GTS1 220kV Line "R, W, B" Including 3 x Single Phase Post Type 245kV CVT
Bay J	Remove	Existing No.1 220kV Capacitor Bank CB Bus side ROI Existing No.1 220kV Capacitor Bank CB Bus side E/SW
	Install	Install one off new No.1 220kV Capacitor Bank CB Bus side ROI/ No.1 220kV Capacitor Bank CB Bus side E/SW - Including 1 x integrated earth switch
	Remove	Existing No.1 220kV Capacitor bank CB CT R, W & B phase
	Install	Install three off new single-phase No.1 220kV Capacitor bank CB CT R, W & B phase
22kV No.1 & 3 S/S TR	Remove	Existing No.1 22kV/415V S/S Trans 22kV fused Isolator Existing No.3 22kV/415V S/S Trans 22kV feeder fused Isolator
	Install	- Install one off new No.1 22kV/415V S/S Trans 22kV fused Isolator - Install one off new No.3 22kV/415V S/S Trans 22kV fused Isolator
	Remove	Existing 22kV A1 TR 22kV VT
	Install	- Install one new 22kV A1 TR 22kV VT

APPENDIX B.2.

The secondary scope to replace the selected 220kV equipment

220kV	Activity	Description (Secondary Equipment)
Bay G (GTS 2)	Remove	Existing GTS2 X Digital Current Differential Relay Existing GTS2 Y Digital Current Diff/Dist Relay
	Install	- Install one – off new GTS2 X&Y Protection and Control scheme to the panel
Bay H	Remove	Existing GTS1 X Digital Current Differential Relay Existing GTS1 Y Digital Current Diff/Dist Relay Existing GTS1/A2 TR CB Control/Monitor Relay T2E
	Install	- Install one-off new GTS 1 X & Y protection & Control scheme to the panel - Install new one-off GTS/A2 TR CB management scheme.
Common Panel	Remove	Existing MLRC VFRB SYS A CONTROL RELAY T2E A Existing MLRC VFRB SYS B CONTROL RELAY T2E A
	Install	Install one off new Fast Runback Satellite System scheme to the panel
	Remove	Existing EMTT SYSTEM 1 PLC RELAY EX500 Existing EMTT SYSTEM 2 PLC RELAY EX500
	Install	Install one off new Emergency Tripping scheme to the panel
	Remove	Existing EGRS SYSTEM 1 PLC RELAY EX500 Existing EGRS SYSTEM 2 PLC RELAY EX500

	Install	Install one off new Emergency Reduction scheme to the panel