APD ENGINEERING

SYDENHAM TERMINAL STATION

TRANSMISSION REVENUE RESET (TRR) PROJECT SCOPING

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REVISION HISTORY

REV	DESCRIPTION	PREPARED BY	CHECKED BY	APPROVED BY	DATE
A	First issue	[C-I-C]	[C-I-C]	[C-I-C]	20/09/2019
B	First issue	[C-I-C]	[C-I-C]	[C-I-C]	07/10/2019

PREPARED FOR

[C-I-C]

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EXECUTIVE SUMMARY

AusNet Services has engaged APD Engineering to prepare project scopes and estimates relating to options for the replacement of poor condition primary and secondary equipment at Sydenham Terminal Station (SYTS) 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 additional APD Engineering has considered the potential impact of the Western Victoria Renewable Integration Project on these planning options.

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 maintains a reliable supply to the 500kV backbone transmission network connected through the station and reduces the need for coincident 500kV outages.

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	Replace all 500kV GIS with Indoor GIS (three diameters)	$108.49
2	Replace all 500kV GIS with Indoor GIS (four diameters)	$132.32
3	Replace all 500kV GIS with AIS in-situ (three bays)	$51.01
4	Replace all 500kV GIS with AIS in-situ (four bays)	$66.22
5	Replace all 500kV GIS with AIS in greenfield location	$83.60

TABLE 1 – ESTIMATED CAPITAL COSTS

[C-I-C]
DESIGN MANAGER

1. INTRODUCTION

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

AusNet Services has identified that the existing 500kV outdoor GIS equipment 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.

It has been agreed with AusNet Services that APD Engineering will provide 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.

AEMO are also planning to undertake a new project at SYTS for the reinforcement of the north-west Victorian transmission network. APD Engineering has considered additional options based this project being completed prior to the replacement of the GIS.

Scoping for the 500kV outdoor GIS primary and associated secondary equipment identified for replacement, along with planning options for consideration have been prepared as per reference [1] – Sydenham Terminal Station (SYTS) 500kV GIS Replacement Project TD-0008033.

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

1. The Western Victoria Renewable Integration project has been completed prior to the replacement of the GIS equipment.

2. No allowance has been made for telecommunications replacement.

3. 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.

4. It is assumed that SCIMS hardware can be modified as part of the project. Full replacement of the RTU/SCIMS alarm modification or panel replacement has not been considered.

5. 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 – REPLACE ALL 500KV GIS WITH INDOOR GIS (THREE DIAMETERS)

4.1. OUTLINE OF PROJECT

This option would result in the replacement of the three existing diameters of 500kV outdoor GIS with modern indoor equivalents.

There would be no option for the connection of the KTS – MLTS No 2 500kV line to SYTS.

4.2. OPTION 1 – 500KV WORKS

AusNet Services has identified that the existing 500kV outdoor GIS equipment is in poor condition. To replace this equipment with modern 500kV indoor GIS would require:

1. Construction of a new 500kV GIS building;
2. Installation and commissioning of three new 500kV GIS diameters;
3. Transition of the existing 500kV overhead lines into the building.

It is proposed that the building would be located to the north of the existing control room on site.

The existing rack structures would be retained to maintain the ability to bypass the site for operational reasons. The single line diagram for this option is shown in figure 1.

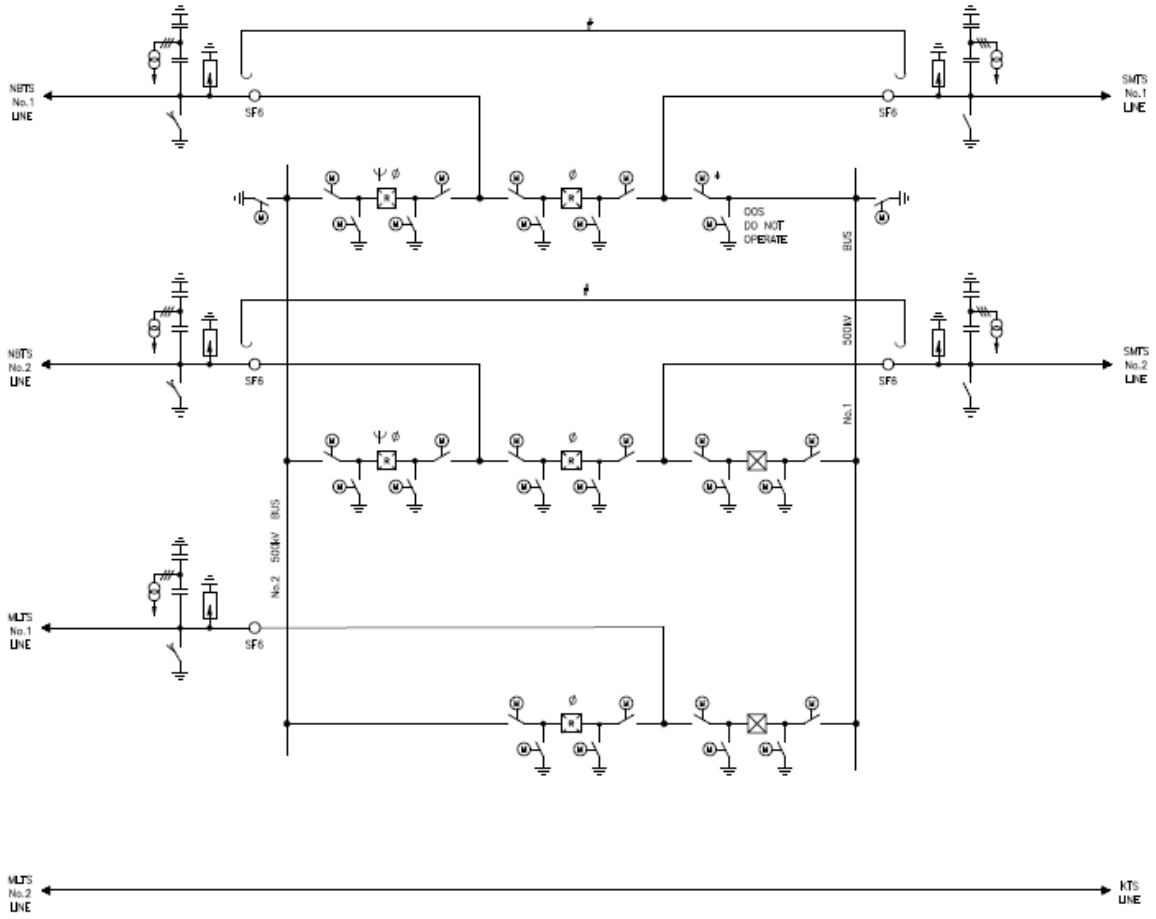

Figure 1 - SYTS 500kV SLD OPTION 1

4.3. OPTION 1 – PLANNING ESTIMATE

The AusNet Services estimating spreadsheet has no information allowing the direct cost calculation for 500kV indoor GIS. The direct cost of this option has been sourced from known industry and manufacturer costs. The direct costs have then been included in the AusNet Services estimating spreadsheet for the calculation of all other costs.

Based on the scopes in Appendix A.1 and A.3, this option has been estimated using the AusNet Services estimating spreadsheet at a total capital cost of $108.49M (±30%).

These costs exclude management contingency.

5. OPTION 2 – REPLACE ALL 500KV GIS WITH INDOOR GIS (FOUR DIAMETERS)

5.1. OUTLINE OF PROJECT

This option would result in the replacement of the three existing diameters of 500kV outdoor GIS with modern indoor equivalents.

This option would allow for the reinstatement of the connection and switching of the KTS – MLTS No 2 500kV line at SYTS.

5.2. OPTION 2 – 500KV WORKS

All of the works required for Option 1 would be required for this option. An additional GIS diameter, along with the transition of two addition 500kV overhead lines.

Again, the existing rack structures would be retained to maintain the ability to bypass the site for operational reasons. The single line diagram for this option is shown in figure 2.

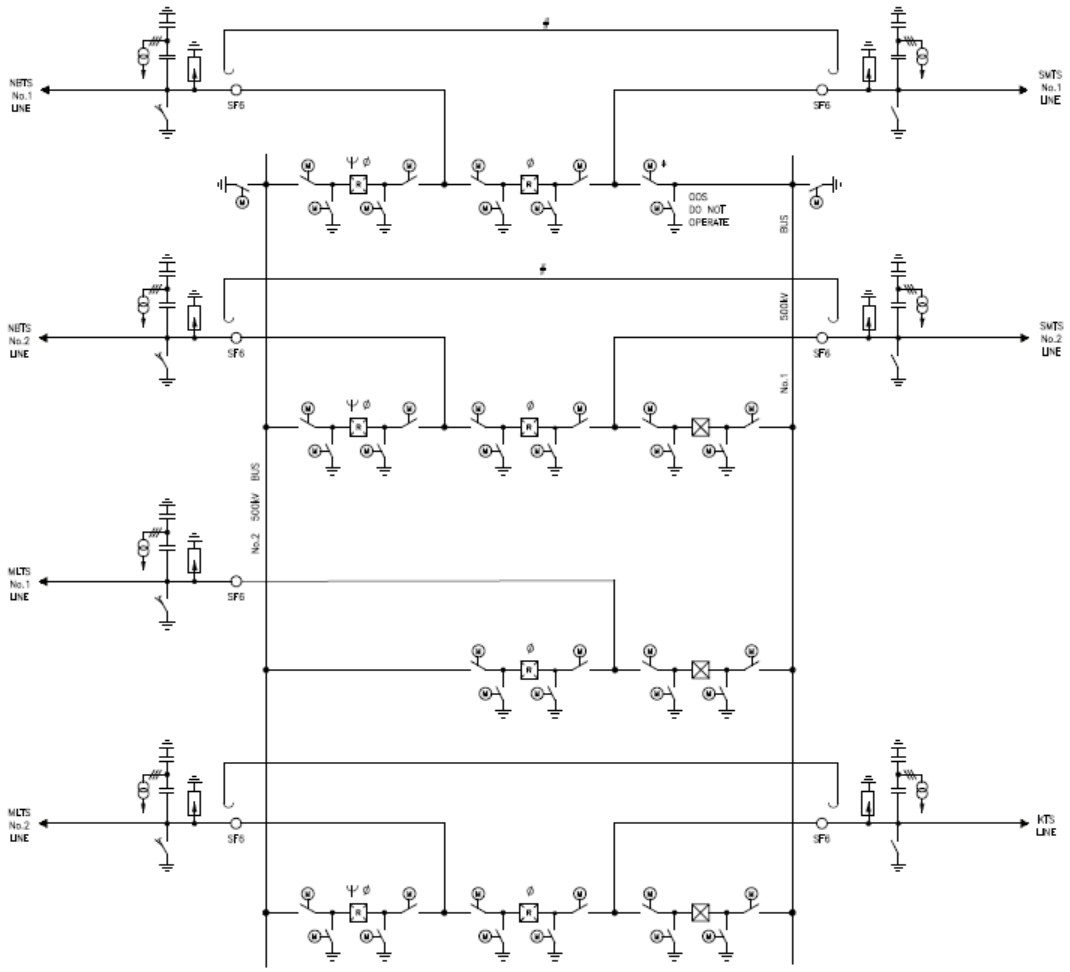

Figure 2 - SYTS 500kV SLD OPTION 2

5.3. OPTION 2 – PLANNING ESTIMATE

The AusNet Services estimating spreadsheet has no information allowing the direct cost calculation for 500kV indoor GIS. The direct cost of this option has been sourced from known industry and manufacturer costs. The direct costs have then been included in the AusNet Services estimating spreadsheet for the calculation of all other costs.

Based on the scopes in Appendix A.2, A.3 and A.4 this option has been estimated using the AusNet Services estimating spreadsheet at a total capital cost of $132.32M (±30%).

These costs exclude management contingency.

6. OPTION 3 – REPLACE EXISTING GIS WITH AIS IN EXISTING LOCATION

6.1. OUTLINE OF PROJECT

This option would result in the existing 500kV outdoor GIS equipment replaced with a modern outdoor AIS solution. This option considers only the replacement of the three GIS diameters.

There would be no option for the connection of the KTS – MLTS No 2 500kV line to SYTS.

6.2. OPTION 3 – 500KV WORKS

AusNet Services has identified that the existing 500kV outdoor GIS equipment is in poor condition.

APD Engineering has confirmed that the existing rack structures are spaced to allow the installation of an AIS solution. These rack structures, however, have been designed for the GIS solution. This has allowed the rack structures to be lower in height and, as such, they are not sufficiently high enough to allow the installation of 500kV AIS switchgear and will need to be replaced.

Replacing the rack structures will require outages of adjacent 500kV equipment for proximity (allowing for plant, equipment and construction crews to work safely).

APD Engineering has identified that the relocation of the existing communications tower will allow installation of additional bays to facilitate the replacement of the existing rack structures with the minimum of coincident 500kV line outages.

APD Engineering has identified a possible construction sequence that will allow temporary connections between the new AIS and the existing GIS. This staging is shown in Appendix B.1 & B.2.

Figure 3 shows the possible final arrangements on site at the completion of the project.

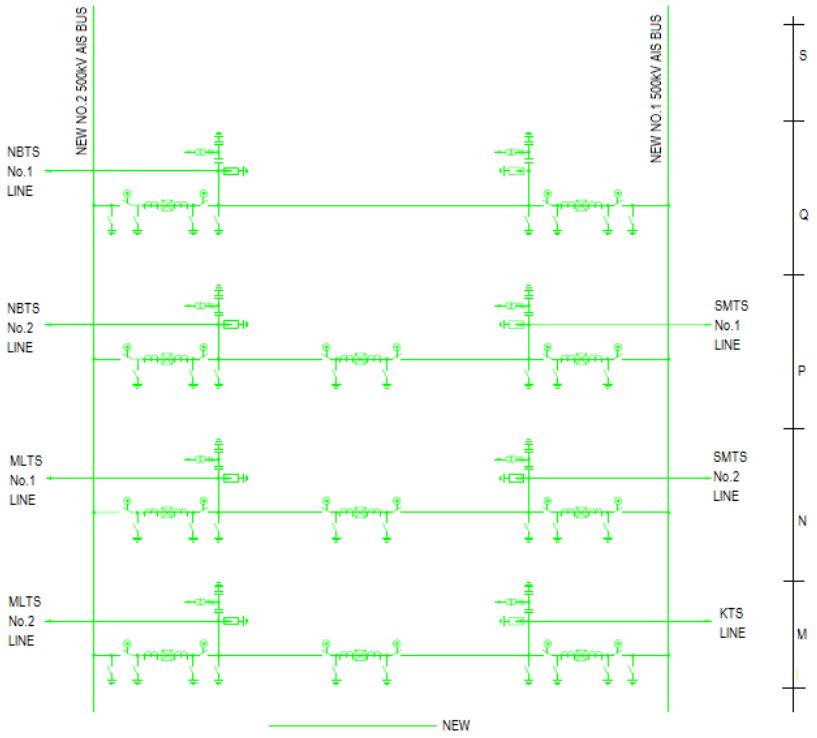

Figure 3 - SYTS 500kV SLD (Final Arrangement)

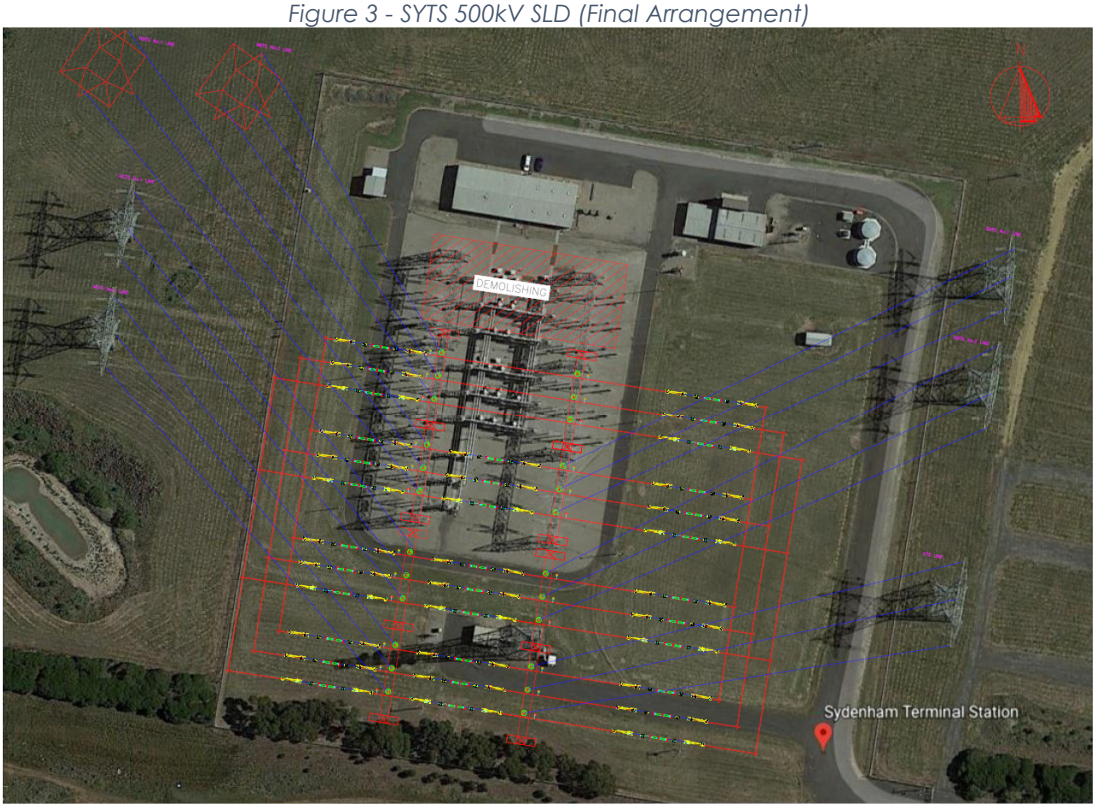

Figure 4 - SYTS General Arrangement (Final)

6.3. OPTION 3 – PLANNING ESTIMATE

Based on the scope in Appendix B.1 and B.2, this option has been estimated using the AusNet Services estimating spreadsheet at a total capital cost of $51.01M (±30%). This cost a excludes any management contingency.

7. OPTION 4 – REPLACE EXISTING GIS WITH AIS IN-SITU AND ADDITIONAL SWITCHGEAR

7.1. OUTLINE OF PROJECT

This option would result in the existing 500kV outdoor GIS equipment replaced with a modern outdoor AIS solution. This option considers the reinstatement of the connection of the KTS – MLTS No 2 500kV line at SYTS.

7.2. OPTION 4 – 500KV WORKS

All of the works required for Option 3 would be required for this option. An additional two rack structures and 500kV breaker and one-half configured switch bay would be required.

7.3. OPTION 4 – PLANNING ESTIMATE

Based on the scope in Appendix B.1, B.2, B.3 and B.4, this option has been estimated using the AusNet Services estimating spreadsheet at a total capital cost of $66.22M (±30%). This cost excludes any management contingency.

8. OPTION 5 – REPLACE EXISTING GIS WITH AIS IN GREENFIELD LOCATION

8.1. OUTLINE OF PROJECT

This option would result in the existing 500kV outdoor GIS equipment replaced with a modern outdoor AIS solution in a green field location north of the existing control room. This option considers the reinstatement of the connection of the KTS – MLTS No 2 500kV line at SYTS.

This option will present a reduced risk profile to the previous AIS options during construction. As this will be a green field site, relative to other options there is reduced risk during construction of damage to in service equipment. Additionally, all construction works for all bays can be completed prior to the energisation and commissioning of any equipment. This will reduce the duration of the project and the duration of the transition from GIS to AIS.

In a greenfield solution, outages of 500kV equipment will be restricted to the energisation and commissioning phase only. This is likely to reduce any STPIS related penalties and the number of coincident outages of 500kV will be minimised.

8.2. OPTION 5 – 500KV WORKS

With the exception of the relocation of the communications tower, all of the works required for Option 4 would be required for this option.

Additional 500kV towers would be required to facilitate the connection of the 500kV lines to the new rack structures.

8.3. OPTION 5 – PLANNING ESTIMATE

Based on the scope in Appendix B.1, B.2, B.3 and B.4 (Including new 500kV take-off towers) this option has been estimated using the AusNet Services estimating spreadsheet at a total capital cost of $83.60M (±30%). This cost a excludes any management contingency.

9. REFERENCES

The following document were applied in preparation of this report.

TYPE	OWNER	TITLE
Document	AusNet	Sydenham Terminal Station (SYTS) 500kV GIS Replacement Project TD-0008033
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	Sydenham Terminal Station 500kV Single Line Diagram – T14/31/205
Drawing	AusNet	Sydenham Terminal Station 500kV Switchyard Layout – T2/66/8

APPENDIX A.

500kV Outdoor GIS primary and secondary assets replacement works within SYTS includes the following primary and secondary assets replacement (GIS to GIS).

APPENDIX A.1.

Replacement of all poor condition 500kV Outdoor GIS assets with 500kV Indoor GIS (3 diameters)

500kV Bay	Activity	Description (Primary)
Bay P	Remove	Existing GIS - KTS 500kV Line NO.2 Bus Side ROI and Existing GIS- KTS 500kV Line Earth Switch
Bay Q	Remove	Existing GIS - MLTS NO.2 500kV Line NO.2 Bus CB Existing GIS - MLTS NO.2 / SMTS NO.2 Line 500kV CB Existing GIS - SMTS NO.2 500kV Line NO.1 Bus CB Existing GIS - MLTS NO.2 500kV Line NO.2 Line Bus CB Line Side CT Existing GIS - MLTS NO.2 500kV Line NO.2 Line Bus CB Bus Side CT Existing GIS - MLTS NO.2 / SMTS NO.2 Line 500kV CB SMTS Line Side CT Existing GIS - MLTS NO.2 / SMTS NO.2 Line 500kV CB MLTS Line Side CT Existing GIS - SMTS NO.2 500kV Line NO.1 Line Bus CB Line Side CT Existing GIS - SMTS NO.2 500kV Line NO.1 Line Bus CB Bus Side CT Existing GIS - MLTS NO.2 500kV Line Earth Switch Existing GIS - MLTS NO.2 500kV Line NO.2 Bus CB Line Side Motorised Earth Switch

		Existing GIS - MLTS NO.2 / SMTS NO.2 Line CB MLTS Line Side Motorised Earth Switch Existing GIS - MLTS NO.2 / SMTS NO.2 Line CB SMTS Line Side Motorised Earth Switch Existing GIS - SMTS NO.2 500kV Line NO.1 Bus CB Bus Side Motorised Earth Switch Existing GIS - SMTS NO.2 500kV Line NO.1 Bus CB Line Side Motorised Earth Switch Existing GIS - SMTS NO.2 500kV Line Earth Switch Existing GIS - MLTS NO.2 500kV Line NO.2 Bus CB Bus Side ROI Existing GIS - MLTS NO.2 500kV Line NO.2 Bus CB Line Side ROI Existing GIS - MLTS NO.2 / SMTS NO.2 Line CB MLTS Line Side ROI Existing GIS - MLTS NO.2 / SMTS NO.2 Line CB SMTS Line Side ROI Existing GIS - SMTS NO.2 500kV Line NO.1 Bus CB Line Side ROI Existing GIS - SMTS NO.2 500kV Line NO.1 Bus CB Bus Side ROI
Bay S	Remove	Spare MERLIN GERIN DHB4 500kV CB Pole Existing GIS - MLTS NO.1 500kV Line NO.2 Bus CB Existing GIS - MLTS NO.1 / SMTS NO.1 Line 500kV CB Existing GIS - MLTS NO.1 500kV Line NO.2 Line Bus CB Line Side CT Existing GIS - MLTS NO.1 500kV Line NO.2 Line Bus CB Bus Side CT Existing GIS - MLTS NO.1 / SMTS NO.1 Line 500kV CB SMTS Line Side CT Existing GIS - MLTS NO.1 / SMTS NO.1 Line 500kV CB MLTS Line Side CT Existing GIS - MLTS NO.1 500kV Line Earth Switch

		Existing GIS - MLTS NO.1 500kV Line NO.2 Bus CB Bus Side Motorised Earth Switch Existing GIS - MLTS NO.1 500kV Line NO.2 Bus CB Line Side Motorised Earth Switch Existing GIS - MLTS NO.1 / SMTS NO.1 Line CB MLTS Line Side Motorised Earth Switch Existing GIS - MLTS NO.1 / SMTS NO.1 Line CB SMTS Line Side Motorised Earth Switch Existing GIS - SMTS NO.1 500kV Line Earth Switch Existing GIS - NO.1 500kV Bus Earth Switch (Out of Service) Existing GIS - NO.1 500kV Bus Motorised Earth Switch Existing GIS - NO.2 500kV Bus Motorised Earth Switch Existing GIS - MLTS NO.1 500kV Line NO.2 Bus CB Bus Side ROI Existing GIS - MLTS NO.1 500kV Line NO.2 Bus CB Line Side ROI Existing GIS - MLTS NO.1 / SMTS NO.1 Line CB MLTS Line Side ROI Existing GIS - MLTS NO.1 / SMTS NO.1 Line CB SMTS Line Side ROI Existing GIS - SMTS NO.1 500kV Line NO.1 Bus Side ROI

New works for indoor GIS (3 diameters):

1. Construction of a new 500kV GIS building (including overhead crane, internal lighting, internal earthing system and fire protection system);
2. Installation and commissioning of three new 500kV GIS diameters (including supply, installation, site testing, commissioning, GIS local control cubicles and secondary systems);
3. Five x 3 phase Surge Arrestors including footings and earthing; and
4. Transition of the existing 500kV overhead lines into the building.

APPENDIX A.2.

Replacement of all poor condition 500kV Outdoor GIS assets with 500kV Indoor GIS (4 diameters)

500kV Bay	Activity	Description (Primary)
Bay P	Remove	Existing GIS - KTS 500kV Line NO.2 Bus Side ROI and Existing GIS- KTS 500kV Line Earth Switch
Bay Q	Remove	Existing GIS - MLTS NO.2 500kV Line NO.2 Bus CB Existing GIS - MLTS NO.2 / SMTS NO.2 Line 500kV CB Existing GIS - SMTS NO.2 500kV Line NO.1 Bus CB Existing GIS - MLTS NO.2 500kV Line NO.2 Line Bus CB Line Side CT Existing GIS - MLTS NO.2 500kV Line NO.2 Line Bus CB Bus Side CT Existing GIS - MLTS NO.2 / SMTS NO.2 Line 500kV CB SMTS Line Side CT Existing GIS - MLTS NO.2 / SMTS NO.2 Line 500kV CB MLTS Line Side CT Existing GIS - SMTS NO.2 500kV Line NO.1 Line Bus CB Line Side CT Existing GIS - SMTS NO.2 500kV Line NO.1 Line Bus CB Bus Side CT Existing GIS - MLTS NO.2 500kV Line Earth Switch Existing GIS - MLTS NO.2 500kV Line NO.2 Bus CB Line Side Motorised Earth Switch Existing GIS - MLTS NO.2 / SMTS NO.2 Line CB MLTS Line Side Motorised Earth Switch Existing GIS - MLTS NO.2 / SMTS NO.2 Line CB SMTS Line Side Motorised Earth Switch Existing GIS - SMTS NO.2 500kV Line NO.1 Bus CB Bus Side Motorised Earth Switch

		Existing GIS - SMTS NO.2 500kV Line NO.1 Bus CB Line Side Motorised Earth Switch Existing GIS - SMTS NO.2 500kV Line Earth Switch Existing GIS - MLTS NO.2 500kV Line NO.2 Bus CB Bus Side ROI Existing GIS - MLTS NO.2 500kV Line NO.2 Bus CB Line Side ROI Existing GIS - MLTS NO.2 / SMTS NO.2 Line CB MLTS Line Side ROI Existing GIS - MLTS NO.2 / SMTS NO.2 Line CB SMTS Line Side ROI Existing GIS - SMTS NO.2 500kV Line NO.1 Bus CB Line Side ROI Existing GIS - SMTS NO.2 500kV Line NO.1 Bus CB Bus Side ROI
Bay S	Remove	Spare MERLIN GERIN DHB4 500kV CB Pole Existing GIS - MLTS NO.1 500kV Line NO.2 Bus CB Existing GIS - MLTS NO.1 / SMTS NO.1 Line 500kV CB Existing GIS - MLTS NO.1 500kV Line NO.2 Line Bus CB Line Side CT Existing GIS - MLTS NO.1 500kV Line NO.2 Line Bus CB Bus Side CT Existing GIS - MLTS NO.1 / SMTS NO.1 Line 500kV CB SMTS Line Side CT Existing GIS - MLTS NO.1 / SMTS NO.1 Line 500kV CB MLTS Line Side CT Existing GIS - MLTS NO.1 500kV Line Earth Switch Existing GIS - MLTS NO.1 500kV Line NO.2 Bus CB Bus Side Motorised Earth Switch Existing GIS - MLTS NO.1 500kV Line NO.2 Bus CB Line Side Motorised Earth Switch Existing GIS - MLTS NO.1 / SMTS NO.1 Line CB MLTS Line Side Motorised Earth Switch

		Existing GIS - MLTS NO.1 / SMTS NO.1 Line CB SMTS Line Side Motorised Earth Switch Existing GIS - SMTS NO.1 500kV Line Earth Switch Existing GIS - NO.1 500kV Bus Earth Switch (Out of Service) Existing GIS - NO.1 500kV Bus Motorised Earth Switch Existing GIS - NO.2 500kV Bus Motorised Earth Switch Existing GIS - MLTS NO.1 500kV Line NO.2 Bus CB Bus Side ROI Existing GIS - MLTS NO.1 500kV Line NO.2 Bus CB Line Side ROI Existing GIS - MLTS NO.1 / SMTS NO.1 Line CB MLTS Line Side ROI Existing GIS - MLTS NO.1 / SMTS NO.1 Line CB SMTS Line Side ROI Existing GIS - SMTS NO.1 500kV Line NO.1 Bus Side ROI

New works for indoor GIS (4 diameters):

1. Construction of a new 500kV GIS building (including overhead crane, internal lighting, internal earthing system and fire protection system);
2. Installation and commissioning of four new 500kV GIS diameters (including supply, installation, site testing, commissioning, GIS local control cubicles and secondary systems);
3. Five x 3 phase Surge Arrestors including footings and earthing; and
4. Transition of the existing 500kV overhead lines into the building.

APPENDIX A.3.

Secondary works (protection only) for 500kV Indoor GIS Bay Extension

500kV Bay	Activity	Description (Secondary)
Bay P	Remove	KTS X Digital Current Differential Relay Panel PA5 KTS Y Digital Current Diff/Distance Relay Panel PA4
	Install	- Install new one-off MLTS NO.1 500kV X Protection Scheme to Panel No. PA5 - Install new one-off MLTS NO.1 500kV Y Protection Scheme to Panel No. PA4 - Install new one-off MLTS NO.1 500kV X Protection Scheme to remote end - Install new one-off MLTS NO.1 500kV Y Protection Scheme to remote end - Install new one-off Interface Termination Cubicles Bay P
Bay Q	Remove	MLTS 2 X DIGITAL Current Diff Relay Panel PB13 MLTS 2 Y DIGITAL Current Diff/Distance Relay Panel PB14 MLTS 2 500KV Line CB Auto Reclose Panel PA11 MLTS 2 500KV Line CB Auto Reclose Volt Interlock Panel PA11 SMTS 2 X DIGITAL Current Diff Relay Panel PB11 SMTS 2 Y DIGITAL Current Diff/Distance Relay Panel PB12
	Install	- Install new one-off NBTS NO.2 Line No.2 Bus CB X & Y CB Management (CB Fail & Control) Scheme to Panel No. PA11 - Install new one-off NBTS NO.2 500kV X Protection Scheme to Panel No. PB13 - Install new one-off NBTS No.2 500kV Y Protection Scheme to Panel No. PB14

		- Install new one-off NBTS NO.2 500kV X Protection Scheme to remote end. - Install new one-off NBTS No.2 500kV Y Protection Scheme to remote end. - Install new one-off NBTS NO.2/ SMTS NO.2 Line CB X & Y CB Management (CB Fail & Control) Scheme to Panel No. PA10 - Install new one-off SMTS NO.2 Line No.1 Bus CB X & Y CB Management (CB Fail & Control) Scheme to Panel No. PA9 - Install new one-off SMTS NO.2 500kV X Protection Scheme to Panel No. PB11 - Install new one-off SMTS No.2 500kV Y Protection Scheme to Panel No. PB12 - Install new one-off SMTS NO.2 500kV X Protection Scheme to remote end. - Install new one-off SMTS No.2 500kV Y Protection Scheme to remote end. - Install new three-off Interface Termination Cubicles Bay Q
Bay S	Remove	MLTS 1 X Digital Current Differential Relay Panel PC12 MLTS 1 Y Digital Current Differential/Distance Relay Panel PC11 SMTS 1 X Digital Current Differential Relay Panel PC10 SMTS 1 Y Digital Current Differential/Distance Relay Panel PC9
	Install	- Install new one-off NBTS NO.1 Line No.2 Bus CB X & Y CB Management (CB Fail & Control) Scheme to Panel No. PA13 - Install new one-off NBTS NO.1 500kV X Protection Scheme to Panel No. PC12 - Install new one-off NBTS No.1 500kV Y Protection Scheme to Panel No. PC11

		- Install new one-off NBTS NO.1 500kV X Protection Scheme to remote end. - Install new one-off NBTS No.1 500kV Y Protection Scheme to remote end. - Install new one-off NBTS NO.1/ SMTS NO.1 Line CB X & Y CB Management (CB Fail & Control) Scheme to Panel No. PA12 - Install new one-off SMTS NO.1 500kV X Protection Scheme to Panel No. PC10 - Install new one-off SMTS No.1 500kV Y Protection Scheme to Panel No. PC9 - Install new one-off SMTS NO.1 500kV X Protection Scheme to remote end. - Install new one-off SMTS No.1 500kV Y Protection Scheme to remote end. - Install new three-off Interface Termination Cubicles Bay S

APPENDIX A.4.

Secondary works (protection only) for 500kV Indoor GIS Bay Extension

500kV Bay	Activity	Description (Secondary)
New Bay N	Install (Bay Extension - Std 1-1/2 CB Bay)	- Install new one-off MLTS NO.2 Line No.2 Bus CB X & Y CB Management (CB Fail & Control) Scheme to Panel - Install new one-off MLTS NO.2 500kV X Protection Scheme to Panel - Install new one-off MLTS No.2 500kV Y Protection Scheme to Panel - Install new one-off MLTS NO.2 500kV X Protection Scheme to remote end. - Install new one-off MLTS No.2 500kV Y Protection Scheme to remote end. - Install new one-off MLTS NO.2/ KTS Line CB X & Y CB Management (CB Fail & Control) Scheme to Panel - Install new one-off KTS Line No.1 Bus CB X & Y CB Management (CB Fail & Control) Scheme to Panel - Install new one-off KTS 500kV X Protection Scheme to Panel - Install new one-off KTS 500kV Y Protection Scheme to Panel - Install new one-off KTS 500kV X Protection Scheme to remote end. - Install new one-off KTS 500kV Y Protection Scheme to remote end.

APPENDIX B.

500kV Outdoor GIS primary and secondary assets replacement works within SYTS includes the following primary and secondary assets replacement (GIS to AIS).

APPENDIX B.1.

Replacement of all poor condition 500kV Outdoor GIS assets with 500kV AIS

500kV Bay	Activity	Description (Primary)
Bay P	Remove	Existing GIS - KTS 500kV Line NO.2 Bus Side ROI and Existing GIS- KTS 500kV Line Earth Switch

	Install (Std Double Switched Bay)	New MLTS No.1 500kV Line NO.1 Bus Live Tank CB New MLTS No.1 500kV Line NO.2 Bus Live Tank CB New MLTS No 1 500kV Line / No 1 500kV Bus CB Line Side CT New SMTS No.1 500kV Line / No.2 500kV Bus CB Line Side CT New MLTS No.1 500kV Line / No.1 500kV Bus CB Bus Side ROI - Including 2 x integrated earth switch New MLTS No.1 500kV Line / No.1 500kV Bus CB Line Side ROI - Including 2 x integrated earth switch New MLTS No.1 500kV Line / No.2 500kV Bus CB Bus Side ROI - Including 2 x integrated earth switch New MLTS No.1 500kV Line / No.2 500kV Bus CB Line Side ROI - Including 1 x integrated earth switch - Install three (3) 500kV Surge Arresters - Install six (6) 500kV Post Insulators - Install two (2) CT Bay Marshalling Boxes - Install two (2) VT Bay Marshalling Boxes - Install two (2) Switchyard GPO and Lighting Marshalling Boxes - Install one (1) No.1 500kV Bus X & Y High Impedance Bus Protection X CT Summation Box - Install one (1) No.2 500kV Bus X & Y High Impedance Bus Protection Y CT Summation Box
Bay Q	Remove	Existing GIS - MLTS NO.2 500kV Line NO.2 Bus CB Existing GIS - MLTS NO.2 / SMTS NO.2 Line 500kV CB Existing GIS - SMTS NO.2 500kV Line NO.1 Bus CB Existing GIS - MLTS NO.2 500kV Line NO.2 Line Bus CB Line Side CT Existing GIS - MLTS NO.2 500kV Line NO.2 Line Bus CB Bus Side CT

		Existing GIS - MLTS NO.2 / SMTS NO.2 Line 500kV CB SMTS Line Side CT Existing GIS - MLTS NO.2 / SMTS NO.2 Line 500kV CB MLTS Line Side CT Existing GIS - SMTS NO.2 500kV Line NO.1 Line Bus CB Line Side CT Existing GIS - SMTS NO.2 500kV Line NO.1 Line Bus CB Bus Side CT Existing GIS - MLTS NO.2 500kV Line Earth Switch Existing GIS - MLTS NO.2 500kV Line NO.2 Bus CB Line Side Motorised Earth Switch Existing GIS - MLTS NO.2 / SMTS NO.2 Line CB MLTS Line Side Motorised Earth Switch Existing GIS - MLTS NO.2 / SMTS NO.2 Line CB SMTS Line Side Motorised Earth Switch Existing GIS - SMTS NO.2 500kV Line NO.1 Bus CB Bus Side Motorised Earth Switch Existing GIS - SMTS NO.2 500kV Line NO.1 Bus CB Line Side Motorised Earth Switch Existing GIS - SMTS NO.2 500kV Line Earth Switch Existing GIS - MLTS NO.2 500kV Line NO.2 Bus CB Bus Side ROI Existing GIS - MLTS NO.2 500kV Line NO.2 Bus CB Line Side ROI Existing GIS - MLTS NO.2 / SMTS NO.2 Line CB MLTS Line Side ROI Existing GIS - MLTS NO.2 / SMTS NO.2 Line CB SMTS Line Side ROI Existing GIS - SMTS NO.2 500kV Line NO.1 Bus CB Line Side ROI Existing GIS - SMTS NO.2 500kV Line NO.1 Bus CB Bus Side ROI

	Install (Std 1-1/2 CB Bay)	New NBTS NO.2 500kV Line NO.2 Bus live tank CB New NBTS NO.2 / SMTS NO.2 Line 500kV live tank CB New SMTS NO.2 500kV Line NO.1 Bus live tank CB New NBTS NO.2 / SMTS NO.2 Line 500kV CB SMTS Line Side CT New NBTS NO.2 / SMTS NO.2 Line 500kV CB NBTS Line Side CT New SMTS NO.2 Line / No 2 Bus 500kV CB NBTS Line Side CT New NBTS NO.2 500kV Line NO.2 Bus CB Bus Side ROI - Including 2 x integrated earth switch New NBTS NO.2 500kV Line NO.2 Bus CB Line Side ROI - Including 1 x integrated earth switch New NBTS NO.2 / SMTS NO.2 Line CB NBTS Line Side ROI - Including 2 x integrated earth switch New NBTS NO.2 / SMTS NO.2 Line CB SMTS Line Side ROI - Including 2 x integrated earth switch New SMTS NO.2 500kV Line NO.1 Bus CB Line Side ROI - Including 1 x integrated earth switch New SMTS NO.2 500kV Line NO.1 Bus CB Bus Side ROI - Including 2 x integrated earth switch - Install six (6) 500kV Surge Arresters - Install Nine (9) 500kV Post Insulators - Install three (3) CT Bay Marshalling Boxes - Install three (2) VT Bay Marshalling Boxes - Install three (3) Switchyard GPO and Lighting Marshalling Boxes

Bay S	Remove	Spare MERLIN GERIN DHB4 500kV CB Pole Existing GIS - MLTS NO.1 500kV Line NO.2 Bus CB Existing GIS - MLTS NO.1 / SMTS NO.1 Line 500kV CB Existing GIS - MLTS NO.1 500kV Line NO.2 Line Bus CB Line Side CT Existing GIS - MLTS NO.1 500kV Line NO.2 Line Bus CB Bus Side CT Existing GIS - MLTS NO.1 / SMTS NO.1 Line 500kV CB SMTS Line Side CT Existing GIS - MLTS NO.1 / SMTS NO.1 Line 500kV CB MLTS Line Side CT Existing GIS - MLTS NO.1 500kV Line Earth Switch Existing GIS - MLTS NO.1 500kV Line NO.2 Bus CB Bus Side Motorised Earth Switch Existing GIS - MLTS NO.1 500kV Line NO.2 Bus CB Line Side Motorised Earth Switch Existing GIS - MLTS NO.1 / SMTS NO.1 Line CB MLTS Line Side Motorised Earth Switch Existing GIS - MLTS NO.1 / SMTS NO.1 Line CB SMTS Line Side Motorised Earth Switch Existing GIS - SMTS NO.1 500kV Line Earth Switch Existing GIS - NO.1 500kV Bus Earth Switch (Out of Service) Existing GIS - NO.1 500kV Bus Motorised Earth Switch Existing GIS - NO.2 500kV Bus Motorised Earth Switch Existing GIS - MLTS NO.1 500kV Line NO.2 Bus CB Bus Side ROI Existing GIS - MLTS NO.1 500kV Line NO.2 Bus CB Line Side ROI Existing GIS - MLTS NO.1 / SMTS NO.1 Line CB MLTS Line Side ROI Existing GIS - MLTS NO.1 / SMTS NO.1 Line CB SMTS Line Side ROI

		Existing GIS - SMTS NO.1 500kV Line NO.1 Bus Side ROI
	Install (Std 1-1/2 CB Bay)	New NBTS NO.1 500kV Line NO.2 Bus Live Tank CB New NBTS NO.1 / SMTS NO.1 Line 500kV Live Tank CB New SMTS NO.1 500kV Line NO.1 Bus Live Tank CB New NBTS NO.1 500kV Line / NO.2 Bus CB Line Side CT New NBTS NO.1 Line / SMTS NO.1 Line CB SMTS Line Side CT New SMTS NO.1 500kV Line / NO.1 Bus CB Line Side CT New NBTS NO.1 500kV Line NO.2 Bus CB Bus Side ROI - Including 2 x integrated earth switch New NBTS NO.1 500kV Line NO.2 Bus CB Line Side ROI - Including 2 x integrated earth switch New NBTS NO.1 / SMTS NO.1 Line CB NBTS Line Side ROI - Including 1 x integrated earth switch New NBTS NO.1 / SMTS NO.1 Line CB SMTS Line Side ROI - Including 1 x integrated earth switch New SMTS NO.1 500kV Line NO.1 Bus CB Line Side ROI - Including 2 x integrated earth switch New SMTS NO.1 500kV Line NO.1 Bus CB Bus Side ROI - Including 2 x integrated earth switch - Install six (6) 500kV Surge Arresters - Install Nine (9) 500kV Post Insulators - Install three (3) CT Bay Marshalling Boxes - Install three (2) VT Bay Marshalling Boxes - Install three (3) Switchyard GPO and Lighting Marshalling Boxes

APPENDIX B.2.

Replacement of all poor condition 500kV Outdoor GIS assets with 500kV AIS

500kV Bay	Activity	Description (Secondary)
Bay P	Remove	KTS X Digital Current Differential Relay Panel PA5 KTS Y Digital Current Diff/Distance Relay Panel PA4
	Install	- Install new one-off MLTS NO.1 500kV X Protection Scheme to Panel No. PA5 - Install new one-off MLTS NO.1 500kV Y Protection Scheme to Panel No. PA4 - Install new one-off MLTS NO.1 500kV X Protection Scheme to remote end - Install new one-off MLTS NO.1 500kV Y Protection Scheme to remote end - Install new one-off Interface Termination Cubicles Bay P
Bay Q	Remove	MLTS 2 X DIGITAL Current Diff Relay Panel PB13 MLTS 2 Y DIGITAL Current Diff/Distance Relay Panel PB14 MLTS 2 500KV Line CB Auto Reclose Panel PA11 MLTS 2 500KV Line CB Auto Reclose Volt Interlock Panel PA11 SMTS 2 X DIGITAL Current Diff Relay Panel PB11 SMTS 2 Y DIGITAL Current Diff/Distance Relay Panel PB12
	Install	- Install new one-off NBTS NO.2 Line No.2 Bus CB X & Y CB Management (CB Fail & Control) Scheme to Panel No. PA11 - Install new one-off NBTS NO.2 500kV X Protection Scheme to Panel No. PB13 - Install new one-off NBTS No.2 500kV Y Protection Scheme to Panel No. PB14

		- Install new one-off NBTS NO.2 500kV X Protection Scheme to remote end. - Install new one-off NBTS No.2 500kV Y Protection Scheme to remote end. - Install new one-off NBTS NO.2/ SMTS NO.2 Line CB X & Y CB Management (CB Fail & Control) Scheme to Panel No. PA10 - Install new one-off SMTS NO.2 Line No.1 Bus CB X & Y CB Management (CB Fail & Control) Scheme to Panel No. PA9 - Install new one-off SMTS NO.2 500kV X Protection Scheme to Panel No. PB11 - Install new one-off SMTS No.2 500kV Y Protection Scheme to Panel No. PB12 - Install new one-off SMTS NO.2 500kV X Protection Scheme to remote end. - Install new one-off SMTS No.2 500kV Y Protection Scheme to remote end. - Install new three-off Interface Termination Cubicles Bay Q
Bay S	Remove	MLTS 1 X Digital Current Differential Relay Panel PC12 MLTS 1 Y Digital Current Differential/Distance Relay Panel PC11 SMTS 1 X Digital Current Differential Relay Panel PC10 SMTS 1 Y Digital Current Differential/Distance Relay Panel PC9
	Install	- Install new one-off NBTS NO.1 Line No.2 Bus CB X & Y CB Management (CB Fail & Control) Scheme to Panel No. PA13 - Install new one-off NBTS NO.1 500kV X Protection Scheme to Panel No. PC12 - Install new one-off NBTS No.1 500kV Y Protection Scheme to Panel No. PC11

		- Install new one-off NBTS NO.1 500kV X Protection Scheme to remote end. - Install new one-off NBTS No.1 500kV Y Protection Scheme to remote end. - Install new one-off NBTS NO.1/ SMTS NO.1 Line CB X & Y CB Management (CB Fail & Control) Scheme to Panel No. PA12 - Install new one-off SMTS NO.1 500kV X Protection Scheme to Panel No. PC10 - Install new one-off SMTS No.1 500kV Y Protection Scheme to Panel No. PC9 - Install new one-off SMTS NO.1 500kV X Protection Scheme to remote end. - Install new one-off SMTS No.1 500kV Y Protection Scheme to remote end. - Install new three-off Interface Termination Cubicles Bay S

APPENDIX B.3.

500kV AIS Bay Extension

500kV Bay	Activity	Description (Primary)
New Bay N	Install ((Bay Extension - Std 1-1/2 CB Bay)	New MLTS NO.2 500kV Line NO.2 Bus Live Tank CB New MLTS NO.2 / KTS Line 500kV Live Tank CB New KTS 500kV Line NO.1 Bus Live Tank CB New MLTS NO.2 500kV Line NO.2 Line Bus CB Line Side CT New MLTS NO.2 / KTS Line 500kV CB SMTS Line Side CT New KTS 500kV Line NO.1 Line Bus CB Line Side CT New MLTS NO.2 500kV Line NO.2 Bus CB Bus Side ROI - Including 2 x integrated earth switch New MLTS NO.2 500kV Line NO.2 Bus CB Line Side ROI - Including 2 x integrated earth switch New MLTS NO.2 / KTS Line CB MLTS Line Side ROI - Including 1 x integrated earth switch New MLTS NO.2 / KTS Line CB SMTS Line Side ROI - Including 1 x integrated earth switch New KTS 500kV Line NO.1 Bus CB Line Side ROI - Including 2 x integrated earth switch New KTS 500kV Line NO.1 Bus CB Bus Side ROI - Including 2 x integrated earth switch - Install six (6) 500kV Surge Arresters - Install Nine (9) 500kV Post Insulators - Install three (3) CT Bay Marshalling Boxes - Install three (2) VT Bay Marshalling Boxes - Install three (3) Switchyard GPO and Lighting Marshalling Boxes

		- Install new three-off Interface Termination Cubicles Bay N

APPENDIX B.4.

500kV AIS Bay Extension

500kV Bay	Activity	Description (Secondary)
New Bay N	Install (Bay Extension - Std 1-1/2 CB Bay)	- Install new one-off MLTS NO.2 Line No.2 Bus CB X & Y CB Management (CB Fail & Control) Scheme to Panel - Install new one-off MLTS NO.2 500kV X Protection Scheme to Panel - Install new one-off MLTS No.2 500kV Y Protection Scheme to Panel - Install new one-off MLTS NO.2 500kV X Protection Scheme to remote end. - Install new one-off MLTS No.2 500kV Y Protection Scheme to remote end. - Install new one-off MLTS NO.2/ KTS Line CB X & Y CB Management (CB Fail & Control) Scheme to Panel - Install new one-off KTS Line No.1 Bus CB X & Y CB Management (CB Fail & Control) Scheme to Panel - Install new one-off KTS 500kV X Protection Scheme to Panel - Install new one-off KTS 500kV Y Protection Scheme to Panel - Install new one-off KTS 500kV X Protection Scheme to remote end. - Install new one-off KTS 500kV Y Protection Scheme to remote end.

APPENDIX C.

The 500kV Outdoor GIS primary assets replacement works within SYTS will require re-alignment of the existing 500kV take-off towers, the following proposed works are as follows.

APPENDIX C.1.

500kV Towers	Activity	Transmission Take-off Towers
Bay P, Q, S & N	Install New Take-off Towers	Installation seven (7) off new 500kV overhead tower structure - Including new footings required to the support structure