South Morang Terminal Station 500 kV GIS Replacement

TRR Network Studies Results

Version 1.0

Document History

Revision	Date	Details
1	22/01/2025	Initial Issue

	Date	Details	Designation
Prepared by:	22/01/2025	[C.I.C]	Engineering Consultant (VoltConsult)
Reviewed by:	22/01/2025	[C.I.C]	Principal Engineer, Strategic Network Planning (AusNet)

Disclaimer

This report has been prepared by VoltConsult Pty Ltd ("VoltConsult") for AusNet Services ("AusNet") and may only be used by AusNet.

In providing the Services, VoltConsult exercised the degree of skill, care and diligence normally exercised by consultants in similar circumstances. Reasonable endeavours were used to confirm with AusNet personnel the required modelling methodology, obtain the necessary data, information, assumptions, computer models, parameters, etc. for the purpose of conducting the transmission network steady-state modelling which has yielded the results outlined in this report. In conducting the modelling and preparing this report, VoltConsult has not independently verified the accuracy of all the information provided to it by AusNet beyond the agreed scope.

Given the numerous factors and theoretical nature of steady-state network modelling, VoltConsult makes no warranty as to the absolute accuracy of the results contained within this report and disclaims any liability resulting from the subsequent conclusions that may be drawn from the results.

To the extent that this report may be affected by data omissions (or unavailability), assumptions, erroneous data or models provided to VoltConsult, neither VoltConsult nor any of its employees, directors or advisors gives any warranty as to the reliability or accuracy of the information, nor accepts any responsibility arising in any other way (including by reason of negligence) for errors or omissions herein, nor accepts liability for any loss or damage suffered by any person or entity placing any reliance on, acting on the basis of, the contents hereof. No party shall be entitled to raise any claim or suit of action on the basis of the contents of this report.

VoltConsult has no responsibility or obligation to update this report to account for events or changes occurring following the date of issue.

Table of Contents

Document History 2
Disclaimer 2
1.0 Introduction 4
2.0 Network Study Methodology 5
3.0 Results 8
3.1 Scenario 1 12
3.2 Scenario 2 12
3.3 Scenario 3 12
3.4 Scenario 4 12
3.5 Scenario 5 12
3.6 Scenario 6 13
3.6.1 Scenario 6a (Winter) 13
3.7 Scenario 7 13
3.8 Scenario 8 13
3.9 Scenario 9 14
3.10 Scenario 10 14
3.11 Scenario 11 14
3.11.1 Scenario 11a (Winter) 14
3.12 Scenario 12 14
3.12.1 Scenario 12a (Winter) 15
3.13 Scenario 13 15
3.14 Scenario 14 15
3.15 Scenario 15 15
3.16 Scenario 16 16
3.17 Scenario 17 16
3.18 Scenario 18 16
3.18.1 Scenario 18a (Winter) 16
3.19 Scenario 19 17
3.20 Scenario 20 17

1.0 Introduction

AusNet is preparing business cases for several major station replacement projects in connection with the 2027-2032 Transmission Revenue Reset (TRR). Some of these projects require network studies (steady-state load flow studies) to assess the market impact of asset failures. To that end, VoltConsult Pty Ltd ("VoltConsult") were engaged by AusNet to conduct load flow studies for certain projects and scenarios using software, models, information and equipment provided by AusNet.

The avoided cost of an asset failure will be used to economically justify the investment in support of AusNet's TRR Capex forecast and will be used as supporting information for the TRR revenue application. The economic justification and related calculations for these projects are not included in VoltConsult's scope but will be completed by others.

The results in this document refer to network studies carried out for the potential replacement of the 500 kV Gas Insulated Switchgear (GIS) at South Morang Terminal Station (SMTS) and are purely technical in nature.

2.0 Network Study Methodology

AusNet obtained an updated PSSE OPDMS network model from AEMO which includes the cut-in of the ELD-TTS and ROTS-TTS 220 kV lines into the SMTS 220 kV Bus. Using this PSSE network model, the specific operating scenarios shown in Table A were studied.

Table A – Network Study Scenarios to be Modelled

Study	Asset Failure Contingency N-1	Asset Failure Contingency N-2	Asset Failure Contingency N-3	Asset Failure Contingency N-4	Secure Operating State Contingency	Newport Power Station
1	SMTS F2 Transformer OOS	None	None	None	SMTS F1 Transformer OOS	On
2	SMTS F2 Transformer OOS	None	None	None	SMTS F1 Transformer OOS	Off
3	SMTS F2 Transformer OOS	SMTS F1 Transformer OOS	None	None	ROTS A1 Transformer OOS	On
4	SMTS F2 Transformer OOS	SMTS F1 Transformer OOS	None	None	ROTS A1 Transformer OOS	Off
5	HWTS-SMTS No.1 Line OOS	None	None	None	HWTS-SMTS No.2 Line OOS	On
6	HWTS-SMTS No.1 Line OOS	None	None	None	HWTS-SMTS No.2 Line OOS	Off
7	HWTS-SMTS No.1 Line OOS	HWTS-SMTS No.2 Line OOS	None	None	ROTS-SMTS Line OOS	On
8	HWTS-SMTS No.1 Line OOS	HWTS-SMTS No.2 Line OOS	None	None	ROTS-SMTS Line OOS	Off
9	HWTS-SMTS No.1 Line OOS	HWTS-SMTS No.2 Line OOS	ROTS-SMTS Line OOS	None	HWTS-CBTS No.4 Line OOS	On
10	HWTS-SMTS No.1 Line OOS	HWTS-SMTS No.2 Line OOS	ROTS-SMTS Line OOS	None	HWTS-CBTS No.4 Line OOS	Off
11	SMTS-SYTS No.1 Line OOS	None	None	None	SMTS-SYTS No.2 Line OOS	On

12	SMTS-SYTS No.1 Line OOS	None	None	None	SMTS-SYTS No.2 Line OOS	Off
13	SMTS-SYTS No.1 Line OOS	SMTS-SYTS No.2 Line OOS	None	None	SMTS-KTS Line OOS	On
14	SMTS-SYTS No.1 Line OOS	SMTS-SYTS No.2 Line OOS	None	None	SMTS-KTS Line OOS	Off
15	SMTS-SYTS No.1 Line OOS	SMTS-SYTS No.2 Line OOS	SMTS-KTS Line OOS	None	TTS-KTS No.1 Line OOS	On
16	SMTS-SYTS No.1 Line OOS	SMTS-SYTS No.2 Line OOS	SMTS-KTS Line OOS	None	TTS-KTS No.1 Line OOS	Off
17	SMTS-SYTS No.1 Line OOS	HWTS-SMTS No.1 Line OOS	None	None	HWTS-SMTS No.2 Line OOS	On
18	SMTS-SYTS No.1 Line OOS	HWTS-SMTS No.1 Line OOS	None	None	HWTS-SMTS No.2 Line OOS	Off
19	SMTS-SYTS No.1 Line OOS	HWTS-SMTS No.1 Line OOS	SMTS-SYTS No.2 Line OOS	HWTS-SMTS No.2 Line OOS	ROTS-SMTS Line OOS	On
20	SMTS-SYTS No.1 Line OOS	HWTS-SMTS No.1 Line OOS	SMTS-SYTS No.2 Line OOS	HWTS-SMTS No.2 Line OOS	ROTS-SMTS Line OOS	Off

Each study followed the general procedure outlined below:

1. Conduct a load flow study (with transformer tap stepping and switched shunt adjustments enabled) on the system in its normal operation configuration
2. Select the buses to be used as a sub-system for the assessment
3. Set the sub-system loads to the levels required
4. Conduct a load flow study to ensure the model is stable after load adjustments
5. Configure the system to match the specific scenario to be studied (i.e. disconnect the applicable plant or line)
6. Conduct a load flow
7. Analyse the load flows and take another key element out of service (OOS) from the network
8. Review the line, bus and transformer voltage and loading results for the sub-system using PSSE's reports function
9. If all parameters are within the required ranges, scale up the sub-system loads by a certain percentage
10. Conduct a load flow
11. Repeat steps 8-10 until a line or transformer reaches its maximum capacity or repeat steps 7-9 if the results show that a different element might be more critical
12. Once the most critical element has been determined and is operating at its maximum capacity while the system is within appropriate voltage limits, record the sub-system loadings
13. Compare the maximum sub-system loading against the forecast loading and ascertain the load at risk

The sub-system in this assessment included loads at ATS, BLTS, BTS, CBTS, DPTS, ERTS, FBTS, GTS, HTS, KTS, MTS, RTS, RWTS, SMTS, SVTS, TSTS, TTS, and WMTS. The buses selected for the sub-system in PSSE were as follows:

100191,100282,100594,100647,100695,100721,100762,100765,100771,100785,100786,100789,100798,100809,100861,100889,
100911,302030,302031,302033,302080,314020,314021,314022,314023,314030,314031,314032,314033,314034,314035,314080,
314081,314082,315020,315030,315080,321030,321031,321032,321033,321080,321081,323530,323531,323532,323533,323534,
323535,323536,323580,324001,324031,324080,326030,326031,326032,326033,326080,326081,328030,328031,328032,328033,
328034,328035,328080,332030,332031,332032,332033,332080,341001,341030,341080,341081,341090,349020,349030,349080,
365022,365032,365080,366020,366021,366022,366023,366030,366031,366032,366033,366034,366035,366080,373030,373080,
373081,373090,373091,373092,373093,373096,373097,374001,374030,374080,377030,377031,377032,377033,377080,379001,
379002,379080,379081,379082,387020,387021,387022,387023,387024,387025,387030,387080

Loads at each of the stations listed above were set to Summer 2029 POE50 forecast levels and scaled up or down according to the requirements of each scenario modelled.

The following short time ratings were used in the assessments:

SMTS H1 and H2 Transformers – 850 MVA
SMTS H3 Transformer – 1,000 MVA
KTS A2, A3, A4 Transformers – 810 MVA
ROTS A1 and A2 Transformers – 1,500 MVA
BTS-RTS 220 kV Underground cable – 650 MVA
KTS-TTS No.1 220 kV Line – 866 MVA
KTS-TTS No.2 220 kV Line – 1,116 MVA
BTS-TTS No.1 220 kV Line – 894 MVA
BTS-TTS No.2 220 kV Line – 1,114 MVA
DDTS-SMTS 330 kV Lines & Series Capacitor Banks – 1,086 MVA (Summer), 1,343 MVA (Winter)
SYTS-MLTS No.1 500 kV Line – 2,522 MVA
SYTS-MLTS No.2 500 kV Line – 2,522 MVA
HWTS-SMTS No.1 500 kV Line – 2,698 MVA
HWTS-SMTS No.2 500 kV Line – 2,698 MVA
HWTS-CBTS No.4 500 kV Line – 3,276 MVA
ROTS-SMTS 500 kV Line – 3,276 MVA
KTS-SMTS 500 kV Line – 2,598 MVA
SMTS-SYTS No.1 500 kV Line – 2,598 MVA
SMTS-SYTS No.2 500 kV Line – 2,651 MVA

3.0 Results

The availability of HWTS-SMTS, ROTS-SMTS, and HWTS-CBTS lines seems to have the greatest impact on the maximum supportable sub-system load. A summary of the key outcomes of each study are shown in Table B below.

Table B – Network Study Scenarios Summary of Outcomes

Study	Asset Failure Contingency N-1	Asset Failure Contingency N-2	Asset Failure Contingency N-3	Asset Failure Contingency N-4	Secure Operating State Contingency	Newport Power Station	Maximum Supportable Sub-System Load (MW)	PSSE Filename	Results Text File
1	SMTS F2 Transformer OOS	None	None	None	SMTS F1 Transformer OOS	On	**7,229**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S1_F1 F2 OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 1 PSSE Reports
2	SMTS F2 Transformer OOS	None	None	None	SMTS F1 Transformer OOS	Off	**6,687**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S2_F1 F2 OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 2 PSSE Reports
3	SMTS F2 Transformer OOS	SMTS F1 Transformer OOS	None	None	ROTS A1 Transformer OOS	On	**7,174**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S3_F1 F2 ROTS A1 OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 3 PSSE Reports
4	SMTS F2 Transformer OOS	SMTS F1 Transformer OOS	None	None	ROTS A1 Transformer OOS	Off	**6,627**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S4_F1 F2 ROTS A1 OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 4 PSSE Reports
5	HWTS-SMTS No.1 Line OOS	None	None	None	HWTS-SMTS No.2 Line OOS	On	**7,491**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S5_HWTS-SMTS 1 and 2 OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 5 PSSE Reports
6	HWTS-SMTS No.1 Line OOS	None	None	None	HWTS-SMTS No.2 Line OOS	Off	**7,082**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S6_HWTS-SMTS 1 and 2	SMTS 500 Study 6 PSSE Reports

							OOS MAX_LDSH_NoDER.sav	
6a (Winter)	HWTS-SMTS No.1 Line OOS	None	None	None	HWTS-SMTS No.2 Line OOS	Off	**7,147**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S6a_HWTS-SMTS 1 and 2 OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 6a PSSE Reports
7	HWTS-SMTS No.1 Line OOS	HWTS-SMTS No.2 Line OOS	None	None	ROTS-SMTS Line OOS	On	**5,372**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S7_HWTS-SMTS 1 and 2 ROTS-SMTS OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 7 PSSE Reports
8	HWTS-SMTS No.1 Line OOS	HWTS-SMTS No.2 Line OOS	None	None	ROTS-SMTS Line OOS	Off	**4,877**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S8_HWTS-SMTS 1 and 2 ROTS-SMTS OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 8 PSSE Reports
9	HWTS-SMTS No.1 Line OOS	HWTS-SMTS No.2 Line OOS	ROTS-SMTS Line OOS	None	HWTS-CBTS No.4 Line OOS	On	**3,855**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S9_HWTS-SMTS 1 and 2 ROTS-SMTS HWTS-CBTS OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 9 PSSE Reports
10	HWTS-SMTS No.1 Line OOS	HWTS-SMTS No.2 Line OOS	ROTS-SMTS Line OOS	None	HWTS-CBTS No.4 Line OOS	Off	**3,581**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S10_HWTS-SMTS 1 and 2 ROTS-SMTS HWTS-CBTS OOS MAX_LDSH_NoDER	SMTS 500 Study 10 PSSE Reports
11	SMTS-SYTS No.1 Line OOS	None	None	None	SMTS-SYTS No.2 Line OOS	On	**7,588**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S11_SMTS-SYTS 1 and 2 OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 11 PSSE Reports
11a (Winter)	SMTS-SYTS No.1 Line OOS	None	None	None	SMTS-SYTS No.2 Line OOS	On	**7,649**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S11a_SMTS-SYTS 1 and 2	SMTS 500 Study 11a PSSE Reports

							OOS MAX_LDSH_NoDER.sav	
12	SMTS-SYTS No.1 Line OOS	None	None	None	SMTS-SYTS No.2 Line OOS	Off	**7,081**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S12_SMTS-SYTS 1 and 2 OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 12 PSSE Reports
12a (Winter)	SMTS-SYTS No.1 Line OOS	None	None	None	SMTS-SYTS No.2 Line OOS	Off	**7,451**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S12a_SMTS-SYTS 1 and 2 OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 12a PSSE Reports
13	SMTS-SYTS No.1 Line OOS	SMTS-SYTS No.2 Line OOS	None	None	SMTS-KTS Line OOS	On	**6,030**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S14_SMTS-SYTS 1 and 2 SMTS-KTS OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 13 PSSE Reports
14	SMTS-SYTS No.1 Line OOS	SMTS-SYTS No.2 Line OOS	None	None	SMTS-KTS Line OOS	Off	**5,393**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S14_SMTS-SYTS 1 and 2 SMTS-KTS OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 14 PSSE Reports
15	SMTS-SYTS No.1 Line OOS	SMTS-SYTS No.2 Line OOS	SMTS-KTS Line OOS	None	TTS-KTS No.1 Line OOS	On	**6,117**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S15_SMTS-SYTS 1 and 2 SMTS-KTS KTS-TTS 1 OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 15 PSSE Reports
16	SMTS-SYTS No.1 Line OOS	SMTS-SYTS No.2 Line OOS	SMTS-KTS Line OOS	None	TTS-KTS No.1 Line OOS	Off	**5,250**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S16_SMTS-SYTS 1 and 2 SMTS-KTS KTS-TTS 1 OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 16 PSSE Reports

17	SMTS-SYTS No.1 Line OOS	HWTS-SMTS No.1 Line OOS	None	None	HWTS-SMTS No.2 Line OOS	On	**7,466**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S17_SMTS-SYTS 1 and HWTS-SMTS 1 2 OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 17 PSSE Reports
18	SMTS-SYTS No.1 Line OOS	HWTS-SMTS No.1 Line OOS	None	None	HWTS-SMTS No.2 Line OOS	Off	**7,134**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S18_SMTS-SYTS 1 and HWTS-SMTS 1 2 OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 18 PSSE Reports
18a (Winter)	SMTS-SYTS No.1 Line OOS	HWTS-SMTS No.1 Line OOS	None	None	HWTS-SMTS No.2 Line OOS	Off	**7,174**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S18a_SMTS-SYTS 1 and HWTS-SMTS 1 2 OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 18a PSSE Reports
19	SMTS-SYTS No.1 Line OOS	HWTS-SMTS No.1 Line OOS	SMTS-SYTS No.2 Line OOS	HWTS-SMTS No.2 Line OOS	ROTS-SMTS Line OOS	On	**5,362**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S19_HWTS-SMTS 1 and 2 ROTS-SMTS SMTS-SYTS 1 and 2 OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 19 PSSE Reports
20	SMTS-SYTS No.1 Line OOS	HWTS-SMTS No.1 Line OOS	SMTS-SYTS No.2 Line OOS	HWTS-SMTS No.2 Line OOS	ROTS-SMTS Line OOS	Off	**4,867**	20240222-160037-max-demand-snapshot-SMTS_cut_in_SMTS 500 S20_HWTS-SMTS 1 and 2 ROTS-SMTS SMTS-SYTS 1 and 2 OOS MAX_LDSH_NoDER.sav	SMTS 500 Study 20 PSSE Reports

3.1 Scenario 1

The maximum supportable sub-system load is approximately 7,229 MW when the SMTS F1 and F2 transformers are OOS, and the Newport Generator is ON.

Under these conditions the SMTS H1 transformer is at its short time rating capacity with a load of 771.1 MW, 354.7 MVAr (848.8 MVA). The BLTS B1 and B3 transformers are heavily overloaded at this sub-system load.

Since the key limiting factor is the SMTS H1 Transformer's short time rating, the maximum supportable sub-system load is the same in winter.

3.2 Scenario 2

The maximum supportable sub-system load is approximately 6,687 MW when the SMTS F1 and F2 transformers are OOS, and the Newport Generator is OFF.

Under these conditions the SMTS H1 transformer is at its short time rating capacity with a load of 773.1 MW, 353.4 MVAr (850 MVA). The BLTS B1 and B3 transformers are heavily overloaded at this sub-system load.

Since the key limiting factor is the SMTS H1 Transformer's short time rating, the maximum supportable sub-system load is the same in winter.

3.3 Scenario 3

The maximum supportable sub-system load is approximately 7,174 MW when the SMTS F1, F2 and ROTS A1 transformers are OOS, and the Newport Generator is ON.

Under these conditions the SMTS H1 transformer is at its short time rating capacity with a load of 775.4 MW, 349.2 MVAr (850.4 MVA). The BLTS B1 and B3 transformers are heavily overloaded, and the ATS B2 transformer slightly overloaded at this sub-system load.

Since the key limiting factor is the SMTS H1 Transformer's short time rating, the maximum supportable sub-system load is the same in winter.

3.4 Scenario 4

The maximum supportable sub-system load is approximately 6,627 MW when the SMTS F1, F2 and ROTS A1 transformers are OOS, and the Newport Generator is OFF.

Under these conditions the SMTS H1 transformer is at its short time rating capacity with a load of 775.2 MW, 348.3 MVAr (849.9 MVA). The BLTS B1 and B3 transformers are heavily overloaded, and the ATS B2 transformer slightly overloaded at this sub-system load.

Since the key limiting factor is the SMTS H1 Transformer's short time rating, the maximum supportable sub-system load is the same in winter.

3.5 Scenario 5

The maximum supportable sub-system load for this scenario is 7,491 MW when the HWTS-SMTS No.1 and No.2 500 kV lines are OOS, and the Newport Generator is ON.

The limiting factor in this scenario is the DDTS-SMTS 330 kV Line summer short time rating. Under this sub-system load the DDTS-SMTS 330 kV Line is operating close to its capacity with a load of 890.6 MW, 616.4 MVAr (1083.1 MVA). The BLTS B1 and B3 transformers are heavily overloaded, ATS B2 and KTS B3 and B4 transformers are slightly overloaded, and the MTS 66 kV Bus is operating at a voltage of just under 0.9 pu at this sub-system load.

The model becomes unstable at a sub-system load greater than this with these two lines OOS. Therefore, this is the maximum supportable sub-system load for this operating scenario.

3.6 Scenario 6

The maximum supportable sub-system load for this scenario is 7,082 MW when the HWTS-SMTS No.1 and No.2 500 kV lines are OOS, and the Newport Generator is OFF.

The limiting factor in this scenario is the DDTS-SMTS 330 kV Line summer short time rating. Under this sub-system load the DDTS-SMTS 330 kV Line is operating at its capacity with a load of 890.6 MW, 621.4 MVAr (1086.0 MVA). The BLTS B1 and B3 transformers are heavily overloaded, the ATS B2 transformer is slightly overloaded at this sub-system load.

3.6.1 Scenario 6a (Winter)

The maximum supportable sub-system load for this scenario is 7,147 MW when the HWTS-SMTS No.1 and No.2 500 kV lines are OOS, and the Newport Generator is OFF.

Under this sub-system load the BLTS B1 and B3 transformers are heavily overloaded, the ATS B2 transformer is slightly overloaded at this sub-system load.

The model becomes unstable at a sub-system load greater than this with these two lines OOS. Therefore, this is the maximum supportable sub-system load for this operating scenario.

3.7 Scenario 7

The maximum supportable sub-system load for this scenario is 5,372 MW when the HWTS-SMTS No.1, No.2 and ROTS-SMTS 500 kV lines are OOS, and the Newport Generator is ON.

The limiting factor in this scenario is the RTS-BTS 220 kV underground cable short time rating. Under this sub-system load the RTS-BTS 220 kV underground cable is operating at its capacity with a load of 594.8 MW, 258.8 MVAr (648.7 MVA). The ROTS-RTS No.1 and No.4 220 kV Lines and the ROTS A1 transformer are operating close to their short time ratings under these load conditions. The CBTS B transformers are slightly overloaded under this sub-system load.

Since the RTS-BTS 220 kV underground cable short time rating is the key limiting factor, the maximum supportable sub-system load for this scenario is the same for each season.

3.8 Scenario 8

The maximum supportable sub-system load for this scenario is 4,877 MW when the HWTS-SMTS No.1, No.2 and ROTS-SMTS 500 kV lines are OOS, and the Newport Generator is OFF.

The limiting factor in this scenario is the RTS-BTS 220 kV underground cable short time rating. Under this sub-system load the RTS-BTS 220 kV underground cable is operating at its capacity with a load of 582.1 MW, 287.5 MVAr (649.2 MVA). The ROTS-RTS No.1 and No.4 220 kV Lines and the ROTS A1 transformer are operating close to their short time ratings under these load conditions. The RTS B2 transformer is also operating close to its rating under this sub-system load.

Since the RTS-BTS 220 kV underground cable short time rating is the key limiting factor, the maximum supportable sub-system load for this scenario is the same for each season.

3.9 Scenario 9

The maximum supportable sub-system load for this scenario is 3,855 MW when the HWTS-SMTS No.1, No.2, ROTS-SMTS and HWTS-CBTS No.4 500 kV lines are OOS, and the Newport Generator is ON.

The limiting factors in this scenario are the RTS-BTS 220 kV underground cable and HWTS-ROTS No.3 500 kV Line short time ratings. Under this sub-system load the RTS-BTS 220 kV underground cable is operating at its capacity with a load of 591.8 MW, 268.2 MVAr (649.7 MVA). The WMTS and DPTS 66 kV buses are operating at a voltage a little above 1.1 pu under these conditions.

Since the RTS-BTS 220 kV underground cable and HWTS-CBTS No.4 500 kV Line short time ratings are the key limiting factors, the maximum supportable sub-system load for this scenario is the same for each season.

3.10 Scenario 10

The maximum supportable sub-system load for this scenario is 3,581 MW when the HWTS-SMTS No.1, No.2, ROTS-SMTS and HWTS-CBTS No.4 500 kV lines are OOS, and the Newport Generator is OFF.

The limiting factor in this scenario is the RTS-BTS 220 kV underground cable short time rating. Under this sub-system load the RTS-BTS 220 kV underground cable is operating at its capacity with a load of 575.2 MW, 303.1 MVAr (650.2 MVA). The WMTS, KTS and DPTS 66 kV buses are operating at a voltage a little above 1.1 pu under these conditions.

Since the RTS-BTS 220 kV underground cable short time rating is the key limiting factor, the maximum supportable sub-system load for this scenario is the same for each season.

3.11 Scenario 11

The maximum supportable sub-system load for this scenario is approximately 7,588 MW when the SMTS-SYTS No.1 and No.2 500 kV lines are OOS, and the Newport Generator is ON.

The limiting factor in this scenario is the DDTS-SMTS 330 kV Line summer short time rating. Under this sub-system load the DDTS-SMTS 330 kV Line is operating at its capacity with a load of 864.2 MW, 658.0 MVAr (1086.2 MVA). The BLTS B1 and B3 transformers are heavily overloaded and the ATS B2 and KTS B3 transformers are slightly overloaded at this sub-system load.

3.11.1 Scenario 11a (Winter)

The maximum supportable sub-system load for this scenario is approximately 7,649 MW when the SMTS-SYTS No.1 and No.2 500 kV lines are OOS, and the Newport Generator is ON.

Under this sub-system load the DDTS-SMTS 330 kV Line is operating at 886.7 MW, 705.4 MVAr (1133.1 MVA). The BLTS B1 and B3 transformers are heavily overloaded and the ATS B2 and KTS B3 and B4 transformers are slightly overloaded at this sub-system load.

The model becomes unstable at a sub-system load greater than this with these two lines OOS. Therefore, this is the maximum supportable sub-system load for this operating scenario.

3.12 Scenario 12

The maximum supportable sub-system load for this scenario is approximately 7,081 MW when the SMTS-SYTS No.1 and No.2 500 kV lines are OOS, and the Newport Generator is OFF.

The limiting factor in this scenario is the DDTS-SMTS 330 kV Line summer short time rating. Under this sub-system load the DDTS-SMTS 330 kV Line is operating at its capacity with a load of 861.6 MW, 660.8 MVAr (1085.8 MVA). The BLTS B1 and B3 transformers are heavily overloaded, and the ATS B2 transformer is slightly overloaded at this sub-system load.

3.12.1 Scenario 12a (Winter)

The maximum supportable sub-system load for this scenario is approximately 7,451 MW when the SMTS-SYTS No.1 and No.2 500 kV lines are OOS, and the Newport Generator is OFF.

The limiting factor in this scenario is the DDTS-SMTS 330 kV Line winter short time rating. Under this sub-system load the DDTS-SMTS 330 kV Line is operating at its capacity with a load of 1,004.1 MW, 892.3 MVAr (1343.3 MVA). The BLTS B1 and B3 transformers are heavily overloaded, the ATS B2 transformer is slightly overloaded, and the SMTS H1 is approaching its limit at this sub-system load.

3.13 Scenario 13

The maximum supportable sub-system load for this scenario is 6,030 MW when the SMTS-SYTS No.1 and No.2 and SMTS-KTS 500 kV lines are OOS, and the Newport Generator is ON.

The limiting factor in this scenario is the SMTS H1 Transformer short time rating. Under this sub-system load the SMTS H1 transformer is operating at its capacity with a load of 842.6 MW, 113.8 MVAr (850.3 MVA). The BLTS B1 and B3 transformers are heavily overloaded at this sub-system load.

Since the SMTS H1 transformer short time rating is the key limiting factor, the maximum supportable sub-system load for this scenario is the same for each season.

3.14 Scenario 14

The maximum supportable sub-system load for this scenario is approximately 5,393 MW when the SMTS-SYTS No.1 and No.2 and SMTS-KTS 500 kV lines are OOS, and the Newport Generator is OFF.

The limiting factor in this scenario is the SMTS H1 Transformer short time rating. Under this sub-system load the SMTS H1 transformer is operating at its capacity with a load of 844.9 MW, 98.5 MVAr (850.7 MVA). The BLTS B1 and B3 transformers are heavily overloaded at this sub-system load.

Since the SMTS H1 transformer short time rating is the key limiting factor, the maximum supportable sub-system load for this scenario is the same for each season.

3.15 Scenario 15

The maximum supportable sub-system load for this scenario is 6,117 MW when the SMTS-SYTS No.1 and No.2, SMTS-KTS 500 kV and TTS-KTS No.1 220 kV lines are OOS, and the Newport Generator is ON.

This sub-system load is slightly higher than that in Scenario 13 even though one additional element is OOS. This is due to less load flowing through the SMTS H1 transformer in this scenario. Therefore, the SMTS H1 transformer short time rating is not the limiting factor in this case. The limiting factor in this scenario is the BTS-RTS 220 kV underground cable short time rating.

Under this sub-system load the BTS-RTS 220 kV underground cable is operating at its capacity with a load of 644.7 MW, 77.9 MVAr (649.4 MVA). The BLTS B1 and B3 transformers and the RTS B2 transformer are overloaded at this sub-system load. Additionally, a number of lines are operating at close to or at their ratings under these conditions. These include the KTS-TTS No.2 220 kV line, BTS-TTS No.3 220 kV line, ROTS-RTS No.1 220 kV line, and the ROTS-RTS No.4 220 kV line.

Since the BTS-RTS 220 kV underground cable short time rating is the key limiting factor, the maximum supportable sub-system load for this scenario is the same for each season.

3.16 Scenario 16

The maximum supportable sub-system load for this scenario is 5,250 MW when the SMTS-SYTS No.1 and No.2, SMTS-KTS 500 kV and TTS-KTS No.1 220 kV lines are OOS, and the Newport Generator is OFF.

The limiting factor in this scenario is the KTS-TTS No.2 220 kV line short time rating. Under this sub-system load the KTS-TTS No.2 220 kV line is operating at its capacity with a load of 1,071.7 MW, 309.4 MVAr (1,115.5 MVA). A number of lines are operating at close to or at their ratings under these conditions. These include the BTS-TTS No.3 220 kV line, ROTS-RTS No.1 220 kV line, and the ROTS-RTS No.4 220 kV line.

Since the KTS-TTS No.2 220 kV line short time rating is the key limiting factor, the maximum supportable sub-system load for this scenario is the same for each season.

3.17 Scenario 17

The maximum supportable sub-system load for this scenario is approximately 7,466 MW when the SMTS-SYTS No.1 and HWTS-SMTS No.1 and No.2 500 kV lines are OOS, and the Newport Generator is ON.

Under this sub-system load the BLTS B1 and B3 transformers are heavily overloaded, ATS B2 and KTS B3 and B4 transformers are slightly overloaded, and the MTS 66 kV Bus is operating at a voltage of just under 0.9 pu.

The model becomes unstable at a sub-system load greater than this with these three lines OOS. Therefore, this is the maximum supportable sub-system load for this operating scenario.

3.18 Scenario 18

The maximum supportable sub-system load for this scenario is approximately 7,134 MW when the SMTS-SYTS No.1 and HWTS-SMTS No.1 and No.2 500 kV lines are OOS, and the Newport Generator is OFF.

The limiting factor in this scenario is the DDTS-SMTS 330 kV Line summer short time rating. Under this sub-system load the DDTS-SMTS 330 kV Line is operating close to its capacity with a load of 891.2 MW, 618.0 MVAr (1084.5 MVA). The BLTS B1 and B3 transformers are heavily overloaded, the ATS B2 transformer is slightly overloaded, and the MTS 66 kV Bus is operating at a voltage of just under 0.9 pu at this sub-system load.

3.18.1 Scenario 18a (Winter)

The maximum supportable sub-system load for this scenario is 7,174 MW when the SMTS-SYTS No.1 and HWTS-SMTS No.1 and No.2 500 kV lines are OOS, and the Newport Generator is OFF.

Under this sub-system load the BLTS B1 and B3 transformers are heavily overloaded, the ATS B2 transformer is slightly overloaded, and the MTS 66 kV Bus is operating at a voltage of just under 0.9 pu.

The model becomes unstable at a sub-system load greater than this with these three lines OOS. Therefore, this is the maximum supportable sub-system load for this operating scenario.

3.19 Scenario 19

The maximum supportable sub-system load for this scenario is approximately 5,362 MW when the HWTS-SMTS No.1, No.2, ROTS-SMTS and SMTS-SYTS No.1 and No.2 500 kV lines are OOS, and the Newport Generator is ON.

The limiting factor in this scenario is the RTS-BTS 220 kV underground cable short time rating. Under this sub-system load the RTS-BTS 220 kV underground cable is operating at its capacity with a load of 602.5 MW, 244.9 MVAr (650.4 MVA). The ROTS-RTS No.1 and No.4 220 kV Lines and the ROTS A1 transformer are operating close to their short time ratings under these load conditions. The CBTS B transformers are also operating close to their ratings under this sub-system load.

Since the RTS-BTS 220 kV underground cable short time rating is the key limiting factor, the maximum supportable sub-system load for this scenario is the same for each season.

3.20 Scenario 20

The maximum supportable sub-system load for this scenario is 4,867 MW when the HWTS-SMTS No.1, No.2, ROTS-SMTS and SMTS-SYTS No.1 and No.2 500 kV lines are OOS, and the Newport Generator is OFF.

The limiting factor in this scenario is the RTS-BTS 220 kV underground cable short time rating. Under this sub-system load the RTS-BTS 220 kV underground cable is operating at its capacity with a load of 589.6 MW, 271.6 MVAr (649.1 MVA).

Since the RTS-BTS 220 kV underground cable short time rating is the key limiting factor, the maximum supportable sub-system load for this scenario is the same for each season.